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ABSTRACT

A notation system for the representation of interacting plans of action is presented in this paper and applied in the analysis of a portion of "Hansel and Gretel." The notation system explicates interactions among plans: how cooperation takes place, how conflicts arise and are resolved, how beliefs about plans determine actions, and how differing beliefs and intentions make a story. A major goal is to represent the plot structure of stories about characters who interact. Much of the complexity of such stories arises because the story is about a conflict between the goals of two characters. A person in conflict with another may try to conceal a conflict or to deceive the other into acting in a particular way. A character may thus construct a plan that is intended to be believed by the other but that is not actually carried out. Such a "virtual plan" plays a central role in "Hansel and Gretel." Deception and differing beliefs of this kind are a common feature of stories in which characters interact. (Author/AA)

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Technical Report No. 88

INTERACTING PLANS

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June 1978

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Abstract

The paper presents a notation system for the representation of interacting plans and applies it in the analysis of a small portion of "Hansel and Gretel". The essential problem for the notation system can be stated as follows: How do we represent the plans that determine behavior in a way that explicates interactions among plans? As the examples illustrate, the problem is not just to show how actions can be organized into plans, but also to show how cooperation takes place, how conflicts arise and are resolved, how beliefs about plans determine actions, and how differing beliefs and intentions make a story. The system incorporates ideas from work on simple, or non-interacting plans, but the focus is on plans in a social context.

A major goal is to represent the plot structure of stories about characters who interact. Much of the complexity of such stories arises because the story is about a conflict between the goals of two characters. A person in conflict with another may try to conceal the conflict or deceive the other into acting in a way that serves his or her own interest at the expense of the other. A character may thus construct a plan that is intended to be believed by the other, but is not actually carried out. The plan constitutes the character's "cover". Such a virtual plan plays a central role in "Hansel and Gretel". Deception and differing beliefs of this kind are a common feature of stories in which characters interact.

> Close to a large forest there lived a woodcutter with his wife and his two children. The boy was called Hansel and the girl Gretel. They were always very poor and had very little to live on. And at one time when there was famine in the land, he could no longer procure daily bread.
>
> The Brothers Grimm

1. Overview

An important aspect of a narrative text is that it relates actions connected through goals, effects and enabling conditions. The statement "We understand actions in terms of goals" has become a truism; actions simply are the way goals are attained. This is true for the realms of conversation, stories, or human activity in general, and there has been extensive work to show just how goals and actions relate. But an important implication of goal-based understanding of actions is often overlooked. If we can interpret an action in terms of goals, then so can others who may be affected by that action. They may then act, not just in terms of their goals, but in terms of their understandings of the actor's goals. This means that when two or more people inter-act, their plans can reach a level of complexity that is difficult to foresee from consideration of single actor plans.

The distinction between simple plans and interacting plans can be seen in the fairy tale, "Hansel and Gretel" (Grimm, 1945). Hansel and Gretel are the children of a woodcutter and his wife, who is their stepmother. The family is poor, so poor that the stepmother is able to convince the kind, but weak-willed father that they should take the children into the

woods and abandon them. Hansel overhears their plan to do so and attempts to foil it by dropping pebbles along the trail. When the parents have left them, Hansel and Gretel are able to return home by following the pebbles in the moonlight. The parents welcome them back home, but soon thereafter a similar episode occurs. This time, however, the door is locked when Hansel attempts to go out to gather pebbles. He resorts to an alternate plan of dropping bread crumbs. Unfortunately, birds eat the crumbs and Hansel and Gretel are lost in the woods. From there, they go on to find the wicked witch and the house "made of bread and roofed with cake". Eventually, they manage to kill the witch and return home to their father. There, they find that their cruel stepmother has mysteriously died in the interim.

An analysis of the first episode would show that Hansel has a goal -- to be able to return home after being taken into the woods. To reach that goal he drops pebbles along the trail so that he and Gretel can retrace their steps. We could understand what Hansel does in terms a plan in which dropping pebbles is an action appropriate to the goal. The plan would show how the actions of dropping pebbles and following the trail fit together, and how they produce desired outcomes for Hansel and Gretel.

But such a plan would be incomplete. Hansel and Gretel are being taken into the woods deliberately by their parents. Hansel knows that he should drop pebbles because he and Gretel have overheard their parents plotting against them. Thus, the children's plan is a response to their conception of their parents' plan. Hansel and Gretel are not just "returning home"

but are "countering" the plan they perceive their parents to have. It would have been of little use for Hansel to drop pebbles on a familiar trail, and, if his parents were planning to kill the children outright, some other response would have been more effective. His action becomes meaningful only with respect to his perception of the structure of his parents' plan. What we soon find is that each of the characters in the fairy tale is acting in a reality determined by his or her perceptions of the others' plans. They continually evaluate what the others are doing and react accordingly. Such behavior, characterized by interacting plans, is fundamentally different from that found for one person plans.

One of our goals is to be able to represent the plot structure of stories about characters who interact. Much of the complexity of such stories arises because the story is about a conflict between the goals of two characters. A person in conflict with another may try to conceal the conflict or deceive the other into acting in a way that serves his or her own interest at the expense of the other. A character may thus construct a plan that is intended to be believed by the other, but is not actually carried out. The plan constitutes the character's "cover". As we shall see, such a virtual plan plays a central role in "Hansel and Gretel". The parents attempt to deceive the children into thinking that they are going on an ordinary wood fetching expedition, in order to conceal their real intent, which is to abandon the children. Deception and differing beliefs of this kind are a common feature of stories in which characters interact.

The paper is organized as follows: Section 2 presents a system for the representation of interacting plans. It is a notational system, but also a record of the generalizations we have discovered in applying the representation to stories, Sesame Street muppet skits, and, tentatively, to natural conversations. Section 3 contains an analysis of the first part of "Hansel and Gretel". Through this analysis we illustrate a number of phenomena that appear to have a generality that goes well beyond this particular story, e.g., achieving multiple goals, social episodes, modifying scripts, and virtual plans. In Section 4 we discuss some of the limitations of the system. In Section 5 we identify eight types of complexities that might account for difficulties in understanding interacting plans. These are discussed in terms of their implications for the development reading skills and for education. Section 6 is the conclusion.

2. The Representation of Interacting Plans

2.1 The Problem

Most formal work on plans has been in artificial domains where the goal has been to produce or recognize a single actor plan. In such domains, the problem of independent actors with conflicting goals has not arisen. For us, the essential problem can be stated as follows: How do we represent the plans that determine behavior in a way that explicates interactions among plans? As the examples to follow illustrate, the problem is not just to show how actions can be organized into plans. We need to do that, but we also need to show how cooperation takes place,

how conflicts arise and are resolved, and how beliefs about plans determine actions, and how differing beliefs and intentions make a story.

We should emphasize that although our work builds on ideas developed in work on planning algorithms (Sacerdoti, 1975; Sussman, 1975; Tate, 1975), and on the use of plans in producing appropriate actions (Cohen, 1978; Perrault & Cohen, 1977) we are not proposing a ne planning algorithm (but see Sections 3.4 - 3.7 and 4.4). Similarly, though plan recognition (Schmidt, Sridharan, & Goodson, 1978), is a necessary part of the process of engaging in interacting plans, we are not discussing plan recognition per se (but see Sections 3.8 and 5). Finally, our principal concern is not with knowing how a plan facilitates understanding of the actions of others (Bruce, 1975, 1977; Schank & Abelson, 1977), though, again, this is an important theme.

We hope, instead, to illuminate a range of phenomena through a notation system that makes possible explicit representation of interacting plans. The system, which is presented in the remainder of Section 2, incorporates ideas from work on simple, or non-interacting plans, but the focus is on plans in a social context.

2.2 Belief Spaces

The representation of interacting plans requires the use of a set of symbols within a space which represents one character's model of the interactive situation. The plans that are

represented are those of the target character and those that the target character believes that the other character is carrying out or intending to carry out. Two separate models are required for representing the separate points of view of the two characters. Figure 1 shows three belief spaces, which indicate that A's belief about B's belief does not match B's actual belief, though it does match A's actual belief.

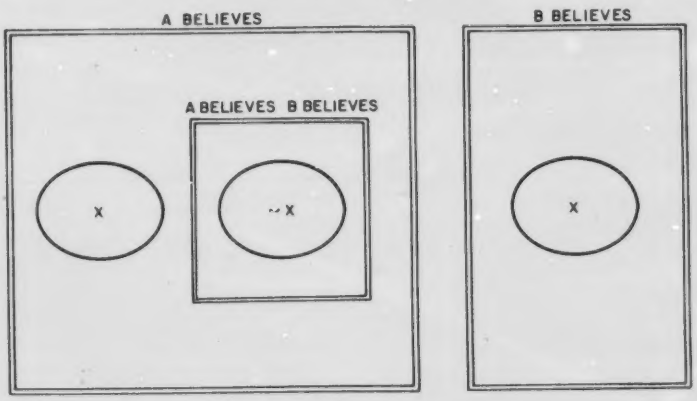


Figure 1. Belief spaces

Within one character's model of the situation there may be a mutual belief space. Any fact falling within this space is believed by the target character to be shared with the other character. That is, character A (whose space it is) believes B believes A believes B believes (etc.) the fact. The use of a mutual belief space within the character's model of the situation is intended to avoid the infinite regression of A's view of B's view of A's view (etc.) of the situation. We will discuss mutual belief spaces in more formal terms in the section on separate

realities. Figure 2 shows a mutual belief space from A's point of view.

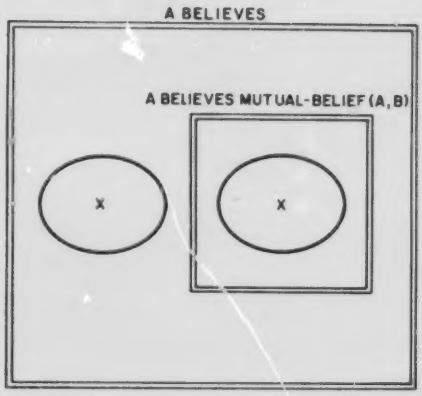


Figure 2. A mutual belief space from A's point of view

A mutual belief space is usually used in representing some cooperative interactive episode between two characters. In the representation of a story that consists of a cooperative episode (where there are no conflicting intentions) both characters' models of the situation can be represented entirely within a mutual belief space. Where conflicting goals and deception are involved, part of at least one character's model of the situation will fall outside of the mutual belief space. On the two dimensional space of a page we are restricted to representing the interactions between only two characters. We use the left to right dimension to separate the actions of the characters and the top to bottom dimension to represent the temporal sequence of the actions. Further details of how the character's plans (which include a representation of the other character's plans) can be

arranged on a two dimensional page will be illustrated in the subsequent analysis of "Hansel and Gretel".

2.3 Basic Nodes of the Representation System

The description of interacting plans ultimately rests upon two basic types of entities, states and acts. Each of these can be either simple or complex (internally structured). Tags are used to mark the temporal, or the real-hypothetical status of the nodes, and there can be various relations between nodes.

It should be emphasized that acts and states are mental entities, that is, they are the target character's conception of aspects of his or her environment. The requirement that acts and states be mental entities and not absolute objective entities lays the foundation for different levels of characterization. People respond to their conception of another's actions. Mismatched conceptions may lead to conflicts or may be the result of deception.

While simple states and acts are represented as primitive we are not assuming that they would be primitive for an actor, rather we are choosing a convenient level of representation. It seems highly unlikely that there could be any set of "primitive" acts or states that would be universal across cultures, ages, or situations. Instead, we can talk of particular characterizations that could be appropriately used in a given context.

2.3.1 States

2.3.1.1 Simple States

Figure 3. A simple state

A state is a partial characterization of an object in terms of attributes and values for those attributes. In the formalism, the indication of a state is actually an indication that someone believes that the state exists.

There is a need for relations between the characters and states. The fact of a given relation between a person and a state will itself be a state that we call a "modal state", or more specifically, an "intentional", or "belief" state.

2.3.1.2 Believes

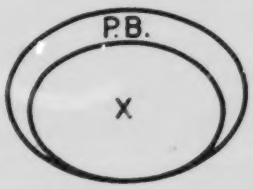


Figure 4. A belief state

The first class of modal states is used to represent belief states of a character. As long as we view the interactive situation from one character's point of view we need not indicate explicitly that that character believes each

specific state, but simply that the representation is of that character's belief system. However, when we need to consider two points of view simultaneously, or more importantly, when we need to show the details of one character's response to their beliefs about another's actions, it will be useful to indicate beliefs explicitly. In general, any state represented is in fact a belief state, and considerations of clarity in presentation determine whether the Believes relation is shown explicitly. Ordinarily nodes will be enclosed within a belief space (q.v.).

2.3.1.3 IntendAchieve

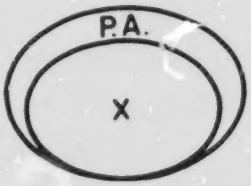


Figure 5. An IntendAchieve state

A second kind of modal state is the state of an actor when he or she intends to bring about a state of affairs that is not presently in existence. The state to be achieved may itself be a modal state. For example, one character may intend to create an intention or a belief in another character.

2.3.1.4 IntendMaintain

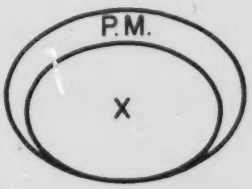


Figure 6. An IntendMaintain state

This third class of modal states differs from an Achieve intention in that the object state is already in existence and the actor's goal is to maintain its existence. While an Achieve intention is satisfied as soon as the object state comes into existence, a Maintain intention is not satisfied until the time period during which the state was supposed to be maintained is over. A Maintain intention may act as a critic (Sacerdoti, 1975) in modifying plans as they are being formed so as to eliminate, introduce, or modify acts in order to avoid states in conflict with the state specified.

2.3.1.5 Social Episodes

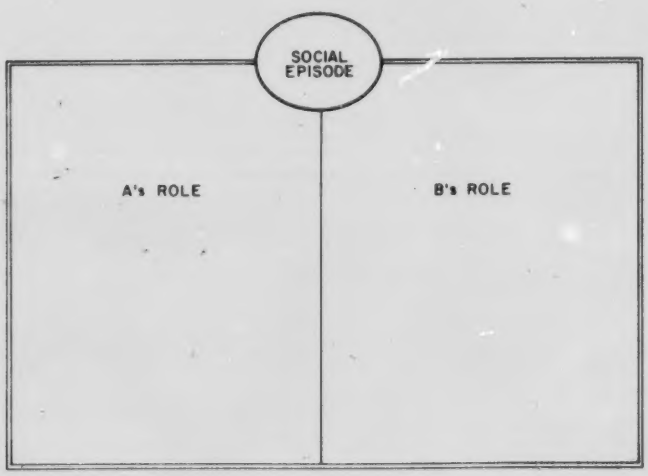


Figure 7. A social episode

A social episode is a state of mutual belief which is created in the process of initiating an ordinary cooperative course of action. The episode is labelled in the state node at

the top. In the space are included the intentions and actions which constitute the roles of the two characters. (The roles of the two characters are differentiated by a dashed line dividing the belief space). By a character's role is meant the actions that the particular character (say, A) expects to perform, and which A believes that the other character expects A to perform. Role also includes the intentions that the other character could reasonably infer from the character's actions given the assumption that they are cooperating. When it is character A's model of the interactive situation that is being represented, character B's intentions are, of course, inferred, while character A's own intentions are known directly. Simple states, unlike modal states, may appear on either side of the role line.

2.3.2 Acts

An act is something an actor does or can do. It is enabled by certain states, and in turn produces or causes other states to occur. Acts are always related (at least indirectly) to intentional states which specify the goal of the act.

2.3.2.1 Simple Acts

Figure 8. A simple act

For a simple act, as for a simple state, no attempt is made to specify an internal structure. Representing an act as simple, however, is not intended as a claim that it has no internal structure but only that the internal structure is not relevant to the representation of interacting plans.

2.3.2.2 Complex Acts

A complex act is a nameable collection of other acts. The various kinds of complex acts and alternative formats for their representation will be presented below in the section on configurations.

2.3.3 Temporal Tags on the Nodes

The nodes (states and acts) can be marked for their temporal status. Any representation of an interacting plan is considered to be capturing a moment in time and indicates what has already occurred (or had been intended or believed), what is currently being done or intended and what is expected to be done or to be the case in the future. Although a single representation shows very little of the process of planning or the execution of a plan, the tags permit some indication of the temporal sequence of the unfolding interaction.

2.3.3.1 Past

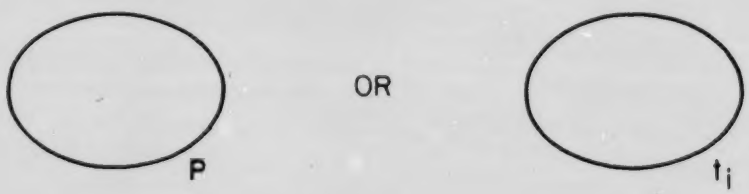


Figure 9. Past states

States that existed (but no longer exist) and acts that took place in the past are indicated by the "P" tag. Alternatively a "t" with a subscript can be used to place the event at some particular time in relation to the other events. Where there are several single representations indicating a temporal unfolding of an interactive plan, the subscripts may appear first on a future act or state, then on a current one and so on.

2.3.3.2 Current

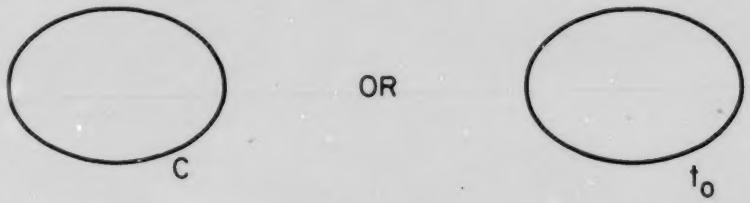


Figure 10. Current states

States or acts that are currently being performed are indicated by the tag "C". Note that an intentional state may be current while the act that would result from the intention may be indicated as future.

2.3.3.3 Future

Figure 11. Future states

Future states and acts are indicated by the "F" tag, or by "t" with a subscript.

2.3.4 Status Indicators for the Nodes

2.3.4.1 Real

Real states and acts are those which the character believes will actually occur, are actually occurring, or have occurred. They are indicated by solid lines.

2.3.4.2 Virtual

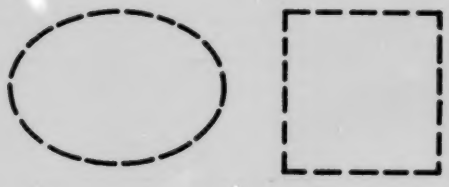


Figure 12. Virtual states and acts.

Virtual states and acts are indicated by dashed lines. These elements are intended by character A to be believed by B to actually occur (will occur, have occurred, or are occurring), but A does not believe them. Whenever a social episode contains virtual elements (from A's point of view), the episode can be considered as a virtual plan of A.

2.3.4.3 Hypothetical

Figure 13. Hypothetical states

A hypothetical state (indicated by a dotted line) is one that an actor can predict would be the result of a future action

or state of affairs but which he or she plans to avoid by modifying the future action or doing some other action to counter the action's expected effect. Hypothetical states show an aspect of the actor's planning (rather than the final plan) in that they indicate how various plans may be coordinated.

2.4 Relations Among the Elements

Relations are the links between states and acts of the interacting plans. They fall into four classes: Planning relations, which indicate how the intended goal is to be accomplished; Outcome relations, which indicate what states result from acts or other states; Precondition relations, which indicate what is needed for an act to be performed; and Markers, which are a representational convenience. Finally there are modifications to outcomes and markers which are required when a state is tagged as hypothetical. The existence of a relation says only that the actor believes that such a relation exists, not that it exists in any absolute sense.

2.4.1 Planning Relations

Planning relations provide links from general intentions (or higher level acts) to the more specific actions (or intentions) that lead toward actualizing the goal:

2.4.1.1 ByMeansOf

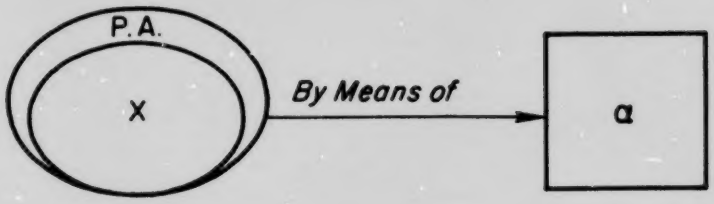


Figure 14. The intention is achieved ByMeans of the act.

The intentional state leads to doing an act. That is, the actor uses a particular act to achieve (or maintain) the goal state specified in the intentional state.

2.4.1.2 Specifies

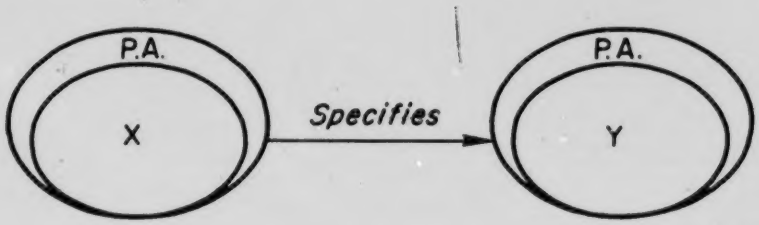


Figure 15. One intention Specifies another.

Achieving State Y is a more specific way of achieving or maintaining State X. That is, in the particular context, achieving or maintaining State Y would count as achieving or maintaining State X. State X is usually a more general characterization of state Y (cf. Produces).

2.4.2 Precondition Relations

These relations link an act to the states which make the act possible or reasonable.

2.4.2.1 Enables

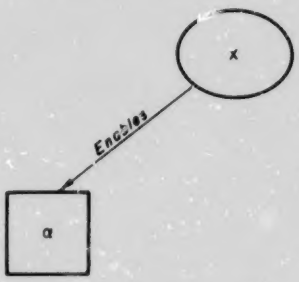


Figure 16. The state Enables the act

This relation indicates that the state is necessary or required for performing the act. Whenever an enabling state is indicated, it must be satisfied before the act can be performed.

2.4.2.2 Supports

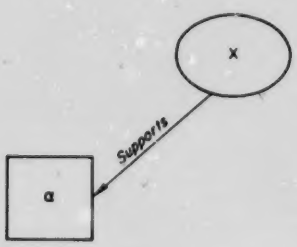


Figure 17. The state Supports the doing of the act.

Here the states is not a necessary preconditin for doing the act, but is a belief that makes doing the act reasonable or appropriate.

2.4.3 Outcome Relations

These relations indicate causal links between acts and states or between two states. The causal mechanisms that are indicated by these relations are not explained in the interactive plans representations but it is assumed that the actors believe them to exist.

2.4.3.1 HasEffect

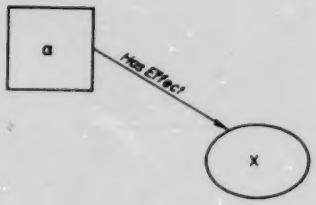


Figure 18. The states is an intended effect of the act

This relation links an act to the state which is its intended consequence.

2.4.3.2 HasSideEffect

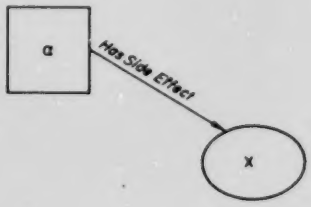


Figure 19. The state is a side effect of the act

A side effect is a state produced by an act that is neither a goal state nor a precondition of another intended act. It is mentioned only when unexpected or when it produces a conflict with another state.

2.4.3.3 Produces

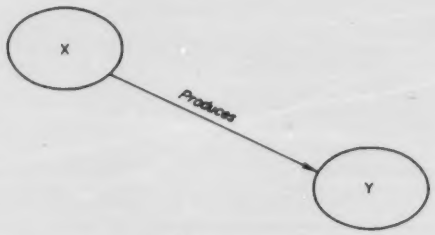


Figure 20. One state Produces another

One state may be the cause of another without the intervention of an actor. The actor, however, may cause a state on the basis of his or her belief that another state would be produced. (Thus an intention to achieve a goal state may Specify another intention to cause the state which will Produce the original goal state).

It is important to point out that the relations, Specifies, Produces, and Supports are intended to summarize, rather than to explain what are often complex relationships. That is, we do not say how a specific intention is selected in a particular problem solving environment, nor how a collection of states produces another state, nor how a state makes an act reasonable. These are important, and of course, difficult questions, but they are not at the core of the issue we are concerned with here, the interconnections among the plans of different actors.

2.4.4 Markers

Markers indicate relations that could be inferred from the configurations of nodes and relations. They do not add new information but are used as a representation convenience.

2.4.4.1 Conflicts

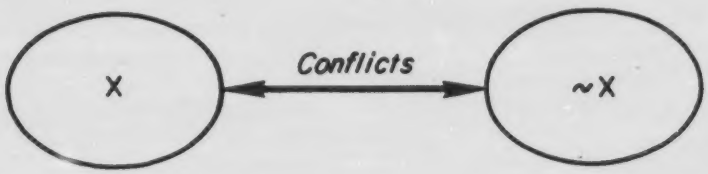


Figure 21. The two states are in conflict

"Conflict" is a symmetric relation that can hold between simple or modal states. Conflict often occurs between a hypothetical state and an intentional state or between belief states of two characters or between intentional states of two characters. Note that within the representation of one character's view of the interactive situation two current simple states are not likely to be in conflict.

2.4.4.2 Satisfies

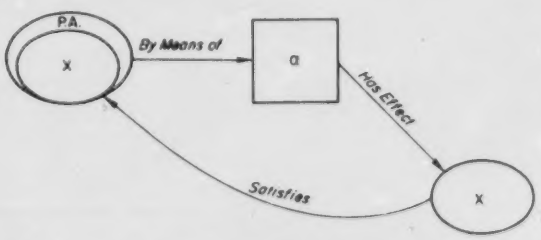


Figure 22. The state Satisfies the intention

When a state occurs which is the object of an Achieve intention, then the satisfaction of the object state can be indicated. For IntendMaintain states, the object state must not only occur but it must endure for the time period indicated by the intention.

2.4.4.3 Counters

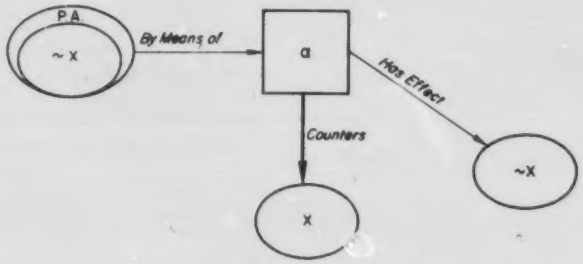


Figure 23. The act Counters the state

This relation indicates that the act was done in order to eliminate (or preempt the occurrence of) some state.

2.4.4.4 SameAs

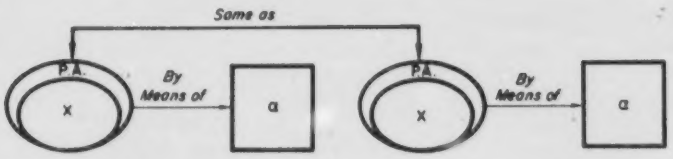


Figure 24. The intentional states are identical

This marker, like the one that follows, is used to indicate the relation between intentional states in a virtual plan and

those in a character's real plan. It always connects identical intentions that lead to identical acts.

2.4.4.5 FillsSlot

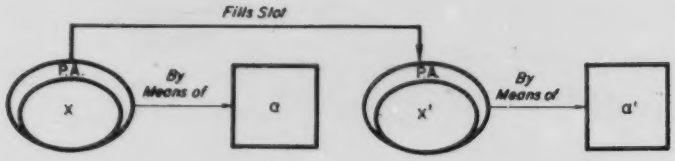


Figure 25. One intention (in a real plan) fills a position in a virtual plan

This marker connects a specific intention in a real plan with a more general intention in a virtual plan. The specific intention fills a slot in the virtual plan which had not been specified.

2.4.5 Hypothetical Modifications

Whenever a hypothetical state is being considered in planning an action sequence, certain of the relations also become hypothetical. This is indicated by adding "would" to the name of the relation. This modification applies to Outcomes and some of the Markers. Thus the following relations are generated:

WouldHaveEffect

WouldHaveSideEffect

WouldProduce

WouldConflict

WouldSatisfy

WouldCounter

2.5 Common Configurations

The heart of our interacting plans analysis lies in what we call "configurations". These are structures built out of the nodes and relations defined in the previous section. Each configuration is a generalization taken from analyses done on social interactions in conversations or stories. The complex of nodes and relations defined in a configuration, rather than just the specific elements (e.g., HasEffect), expresses some assertion about the form of social interaction. In this section we present a few of the most important configurations, each of which has at least one instantiation in the analysis of "Hansel and Gretel" that is to follow.

2.5.1 Satisfaction of Intentions

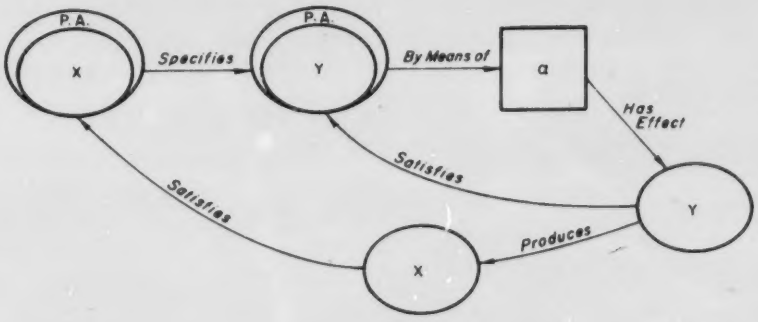


Figure 26. Satisfaction of intentions

Figure 26 shows a simple configuration, the satisfaction of intentions. An Achieve intention has specified another Achieve intention which is carried out by means of an act. The effect of the act satisfies the second Achieve intention, and produces a

state that satisfies the first. Note that a Maintain intention is satisfied only by the conjunction of the act and the end of the time specified (often implicitly) for the Maintain intention.

2.5.2 Request

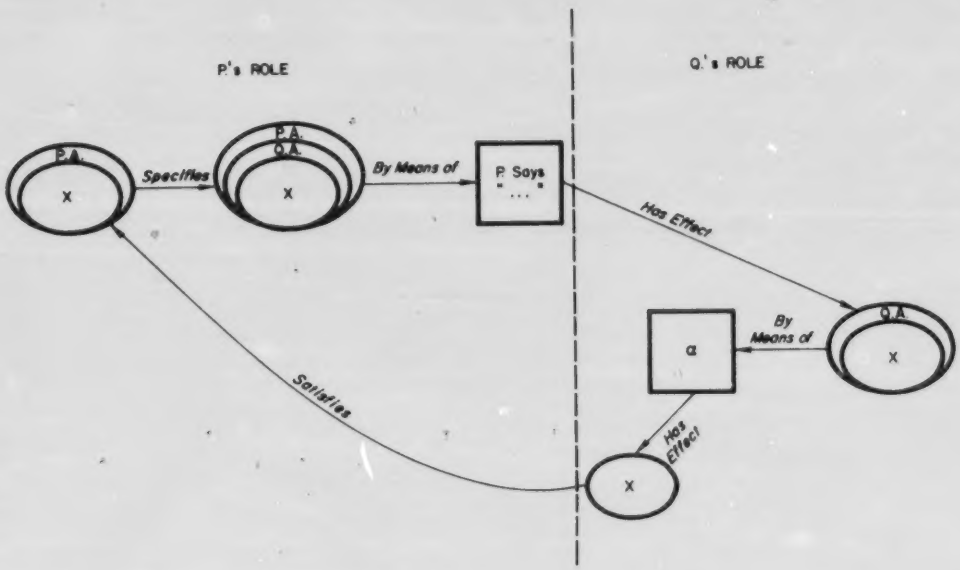


Figure 27. The "request" configuration

One frequently encountered configuration is the "request", as shown in Figure 27. It occurs when a person attempts to achieve a goal by engaging another, and thus represents one of the simpler cases of interaction among plans. In the figure, person P. has the intention to achieve X. Instead of acting directly to bring about X, P. forms a new intention, to achieve the state of Q.'s having the intention to achieve X. This new intention is achieved by means of a speech act, which has the

effect of a new intention for Q. (to achieve X). Note that we have deliberately left out any representation of the usual preconditions and outcomes of the request (see Searle, 1969; Bruce, 1975). We assume that these operate on the beliefs shown in the figure, but are concerned here with the transfer of intentions and the resulting plans.

It should also be pointed out that the figure summarizes a dynamic event, that the intentions, acts and states do not necessarily exist contemporaneously. For example, the doing of the act that effects X brings X into existence (as a belief) but also eliminates the original intention to achieve X. The reader should see Cohen (1978) for a formalism in which this process might be represented.

2.5.3 Resolution of Conflict

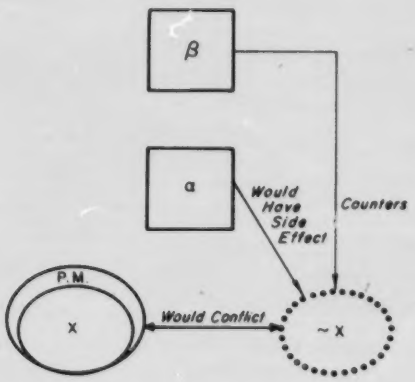


Figure 28. Resolution of a conflict - I

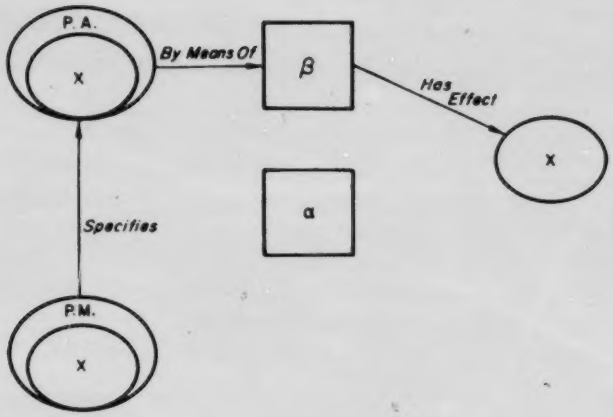


Figure 29. Resolution of a conflict - II

Another common configuration is the "resolution of conflict", as shown in Figures 28 and 29. This occurs in various forms, but typically originates as in Figure 28, when a hypothetical side effect of an act conflicts with some Maintain intention. The Maintain intention is in a sense awakened by the hypothetical state and induced to specify an Achieve intention (Figure 29). The Achieve intention generates an act that counters the hypothetical state.

The resolution of conflicts can occur within simple plans (as in the two previous figures), but also plays an important role in interacting plans. For example, one way to resolve a conflict is to transfer the burden of responsibility, e.g., to use a request to create in another a Maintain intention that will be awakened by the same hypothetical state. This strategy, when successful, will result in the other having to resolve the conflict at a later time. Examples of this occur at several

points in "Hansel and Gretel" (see the section on "Achieving multiple goals").

2.5.4 Initiation of a Social Episode

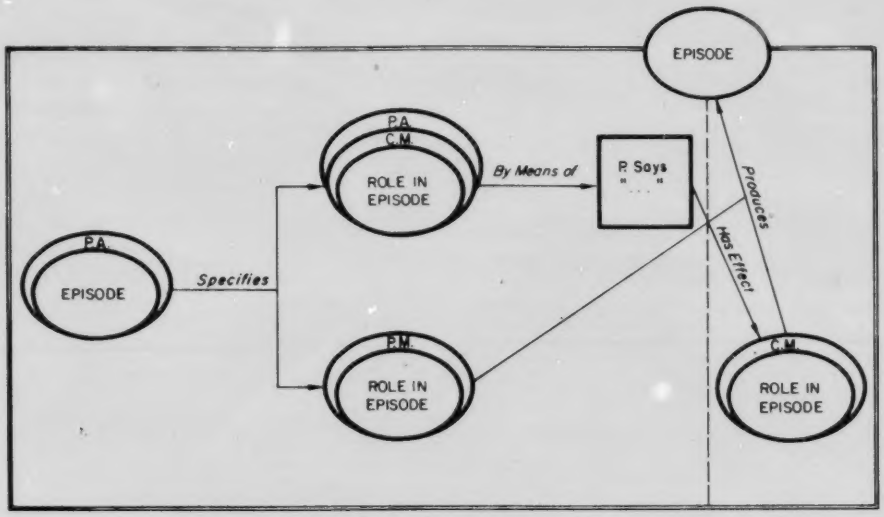


Figure 30. Initiation of a social episode

Another important configuration is the initiation of a social episode, as shown in Figure 30. Often, to achieve certain goals one must engage others in an activity. The activity can be said to commence when the two (or more) participants each have the intention to maintain the activity. We say then that the activity is a social episode. Typically, an episode is initiated by means of a speech act, e.g., "Let's do ...". When successful, the initiation produces a Maintain intention in the second participant. This, plus the Maintain intention of the first participant, produces the episode as a state. The existence of the episode implies a new belief space, namely, a set of beliefs shared between the participants. One of these beliefs is that

the initiation act is precisely that: an act to create the belief space in which it resides.

2.5.5 Complex Act Configurations

The complex act representation is used when the effects of the "lower level" acts in combination produce the effect of the complex act. The representation of an act as "complex", with its decomposition into "simple" acts, indicates that the effects (or preconditions or other aspects) of the component acts are relevant to representing interacting plans. Note that complex acts can be contained within complex acts (see the parent's plan in Figure 44). The acts within a complex act can be related in many possible ways, three of which we identify here.

2.5.5.1 Independent Sub-Acts

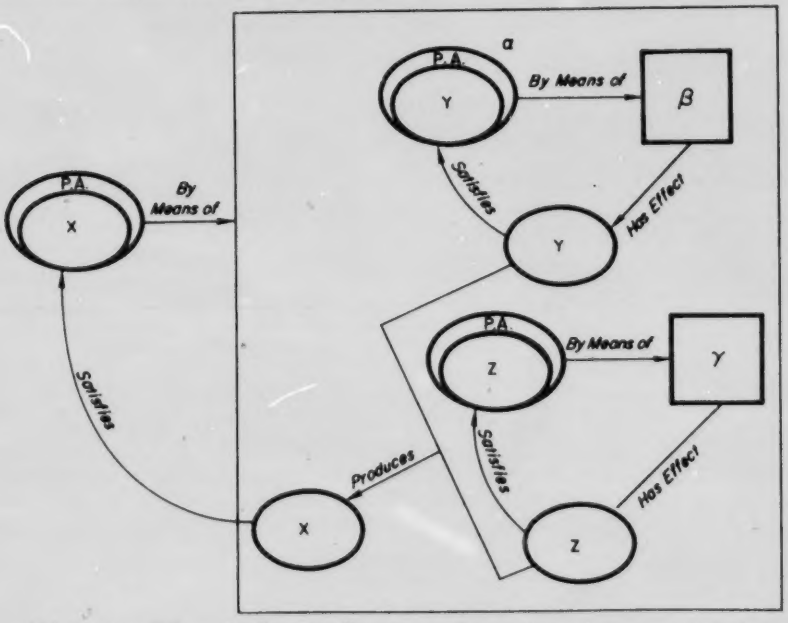


Figure 31. Independent sub-acts in a complex act

In "setting a table" (ALPHA), one could set glasses (BETA) before or after setting plates (GAMMA).

2.5.5.2 Enabling Sub-Acts

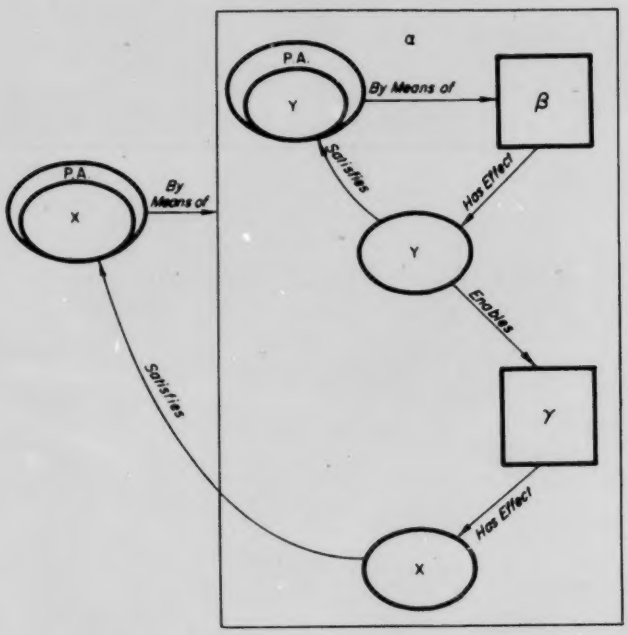


Figure 32. Enabling sub-acts in a complex act

In "starting a fire" (ALPHA), one needs to gather combustible materials together (BETA) before lighting them (GAMMA). The act of "gathering" has an effect (HasEffect) --- the state of "materials together" (Y) which makes possible (Enables) the act of "lighting". Not all HasEffect - Enables

chains need to be characterized as complex acts (e.g., Hansel's pebble gathering as shown in Figure 35).

2.5.5.3 Patching Sub-Acts

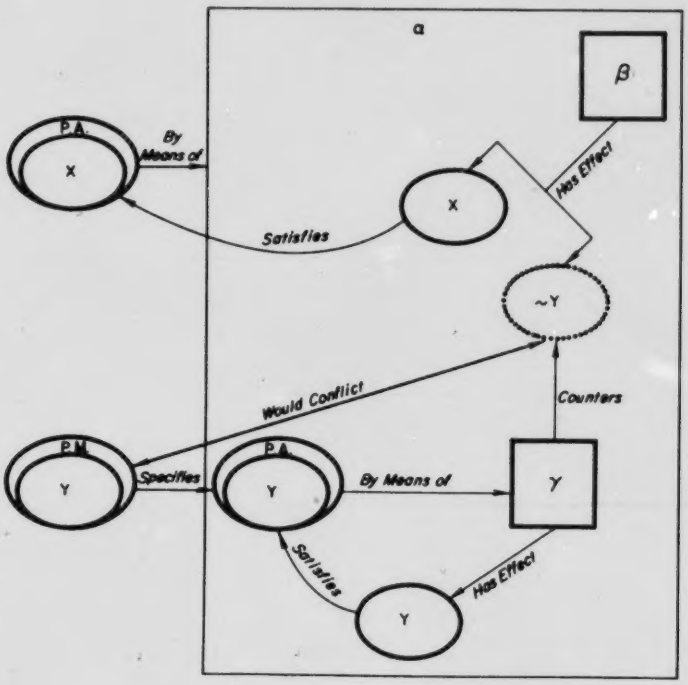


Figure 33. Patching sub-acts in a complex act

In "writing a letter" (ALPHA), the act of "getting out a writing implement" (BETA) has an effect which may need to be countered after the writing is done, by another act, "putting away the writing implement" (GAMMA).

2.5.5.4 ByDoing

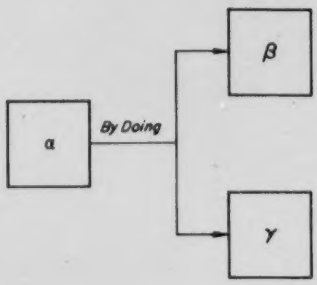


Figure 34. The ByDoing abbreviation

This relation provides for abbreviating complex acts. While the complex act representation shows the intentional states which lead to doing the lower level acts, the ByDoing relation allows for a direct link between the higher level act and the lower level acts. Whenever this relation is used, it can be assumed to be expandable into one of the three types of complex act representations.

3. An Interacting Plans Analysis of Hansel and Gretel

3.1 A Guide to the Analysis

The examples to follow are all taken from "Hansel and Gretel". We are using an English translation, one of the older variety that has not been shortened or altered in major ways. The full text of the section of the story we are analyzing appears in the Appendix.

In this paper we will consider only a small part of the story: the first attempt of the parents to get rid of the

children. In fact, we will focus on one aspect of the episode --- the interactions between the plan of the parents to abandon the children and the plan of the children to block their parent's plan. The interactions occur in the context of a virtual plan, the plan that the parents use to make the children believe that nothing unusual is about to happen when they go into the woods. The parents do not intend to carry out this virtual plan, yet they want the children to treat it as the real plan. In addition to its importance in this story, the virtual plan serves as a model for normal interactive episodes since its effectiveness depends upon its mimicking of real plans.

There are several restrictions we have been forced to place on the analysis. These are discussed in a later section, but one needs to be mentioned here. Though there are four characters in the episode: the father, the stepmother, Hansel and Gretel, we will describe the episode as if there were only two: the parents and the children. In describing the children's real plan, however, we will attribute it to Hansel, since he takes primary responsibility for formulating it and carrying it out.

For details of notation the reader should consult the section on the notation system. Some general points are the following: In each diagram time is indicated by position on the page. Generally speaking, earlier states and acts appear near the top of the page, so that the episode can be "read" from the top of the diagram to the bottom. The parents' intentions and actions are always on the left side of the page, with higher level intentions farther to the left. The children's intentions

and actions are always on the right side, with higher level intentions farther to the right.

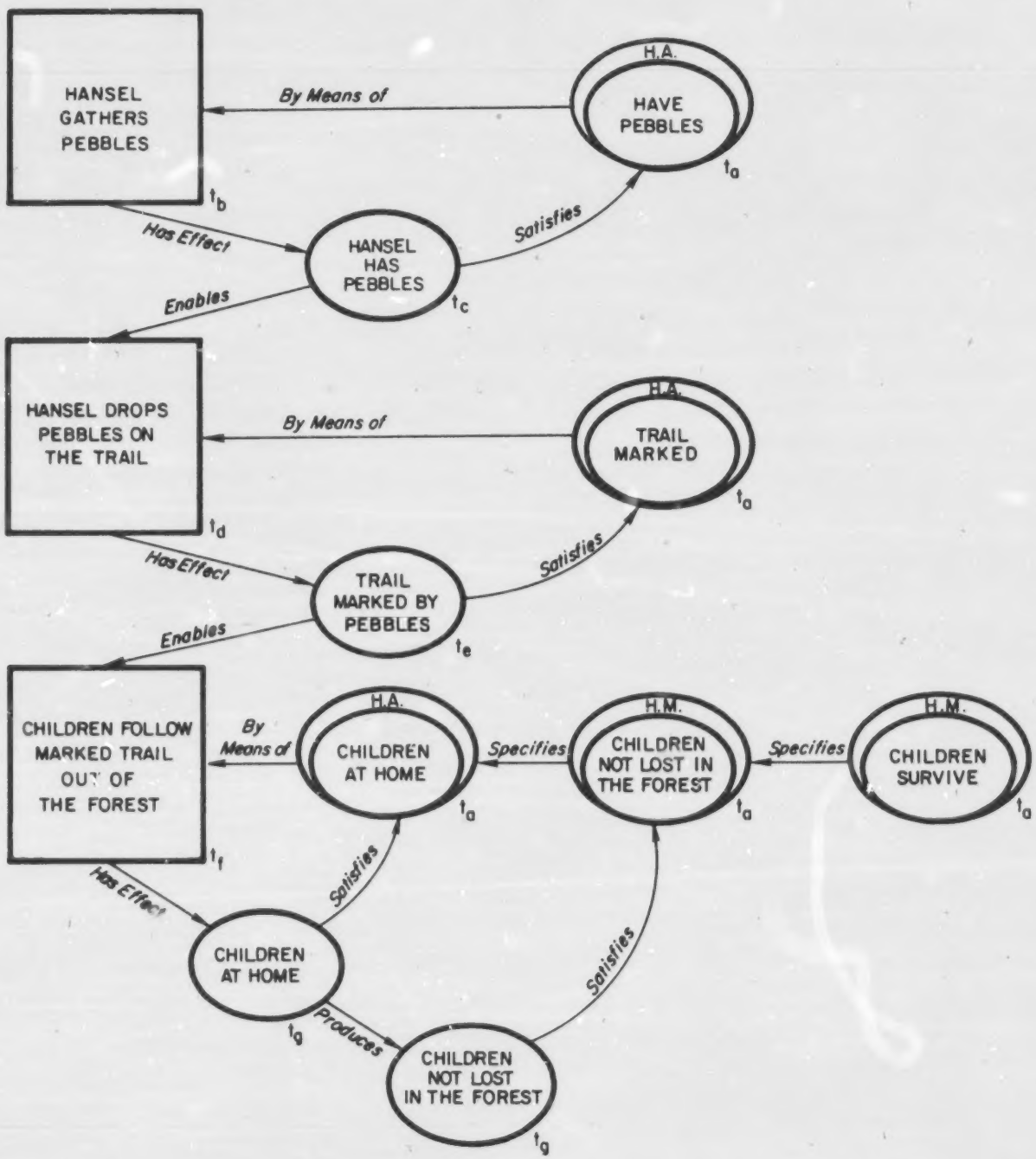
3.2 Achieving a goal with a Sequence of Actions

> When the old people had gone to sleep, he got up, put on his little coat, opened the door, and slipped out. The moon was shining brightly and the white pebbles round the house shone like newly minted coins. Hansel stooped down and put as many into his pockets as they would hold.
>
> Then he went back to Gretel and said, "Take comfort, little sister, and go to sleep. God won't forsake us." And then he went to bed again.
>
> ***
>
> Then they all started for the forest.
>
> When they had gone a little way, Hansel stopped and looked back at the cottage, and he did the same thing again and again ... He had been dropping a pebble on the ground each time he stopped.
>
> ***
>
> When the full moon rose, Hansel took his little sister's hand and they walked on, guided by the pebbles, which glittered like newly coined money. They walked the whole night, and at daybreak they found themselves back at their father's cottage.

We can begin our description of the first episode of Hansel and Gretel with a relatively simple configuration. Figure 35 represents a simple plan for finding one's way out of a forest. It is part of Hansel's plan for surviving his parents' attempts to be rid of the children.

Acts are represented in the figure by square nodes. They are connected to states (oval nodes) by various relations, indicated by the labels on the arrows. For example, the act, "Hansel gathers pebbles", has the effect (HasEffect) of the

Figure 35. Part of Hansel's plan for getting out of the forest



state, "Hansel has pebbles". Modal states, indicated by the embedded ovals, contain some mental attitude, e.g., an intention, and a simple state as the object of the attitude.

Hansel's highest level intention is seen on the far right of the figure. This intention specifies that he and Gretel not be lost in the forest, or more specifically, that they get back home. All of Hansel's intentions in Figure 35 are tagged with time ta indicating that they are present at the outset of carrying out the plan. While the sequence of actions are carried out from top to bottom, the intention to be at home is done directly by means of the last action of following the trail. This action, however, requires that the trail be marked and this, in turn, requires that Hansel has a supply of pebbles with which to do the marking. Thus, the first two actions are done in order to establish the preconditions of the final action that gets the children home.

This plan, which is represented in isolation from the context of the interaction with the parents, is only a small part of what the reader would have to understand in order to follow the events of the story. The plan takes over 24 hours to carry out. Concurrently, the parents are carrying out their plan to lose the children in the forest. It is the interaction of these two plans which we will attempt to represent. The parents' plan will be described in some detail before we return to show how Hansel's plan counteracts the effects of the parents' plan.

3.3 A Simple Interacting Plan: a 'Request'

> When they reached the middle of the forest, their father said, "Now, children, pick up some wood. I want to make a fire to warm you."
> Hansel and Gretel gathered the twigs together and soon made a huge pile. Then the pile was lighted ...

The parents' plan is an interacting plan, since it is a plan to achieve goals in interaction with the children. The idea of an interacting plan can be illustrated with a simple example (see above) taken from their overall plan. Figures 36 and 37 represent the parents' plan to build a fire for the children once they are out in the forest. (For simplicity of presentation, this sub plan will not be represented in the parents' full plan illustrated later on.)

One action ("Parents light pile of twigs") is shown in Figure 36. Fire burning is a simple state which satisfies the intentional state (labelled "P. A.") which is the mental state leading directly to the act. The IntendAchieve state is specified by an IntendMaintain state which in this case is the more general intention to keep the children warm. Since the parents know that a burning fire will produce warm children, they know that the general goal of keeping the children warm can be accomplished in this case by causing a fire to be burning.

The link to Figure 37 is the state "Twigs in pile". This is a necessary condition for the pile of twigs to be lit so it is linked to the act of lighting by an Enables relation. Whenever an act has an enabling condition that is not met, an intention to achieve that state is generated. In Figure 37 that intention is

Figure 36. The parents' plan to keep the children warm

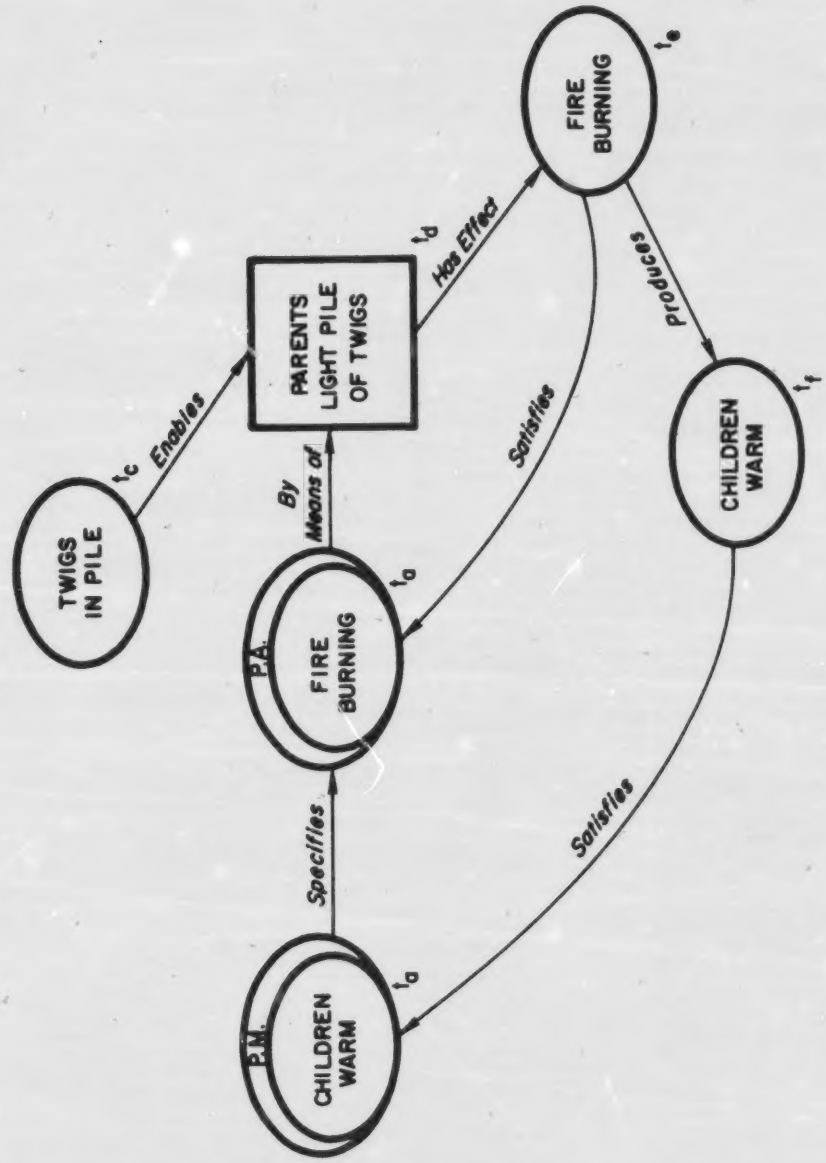
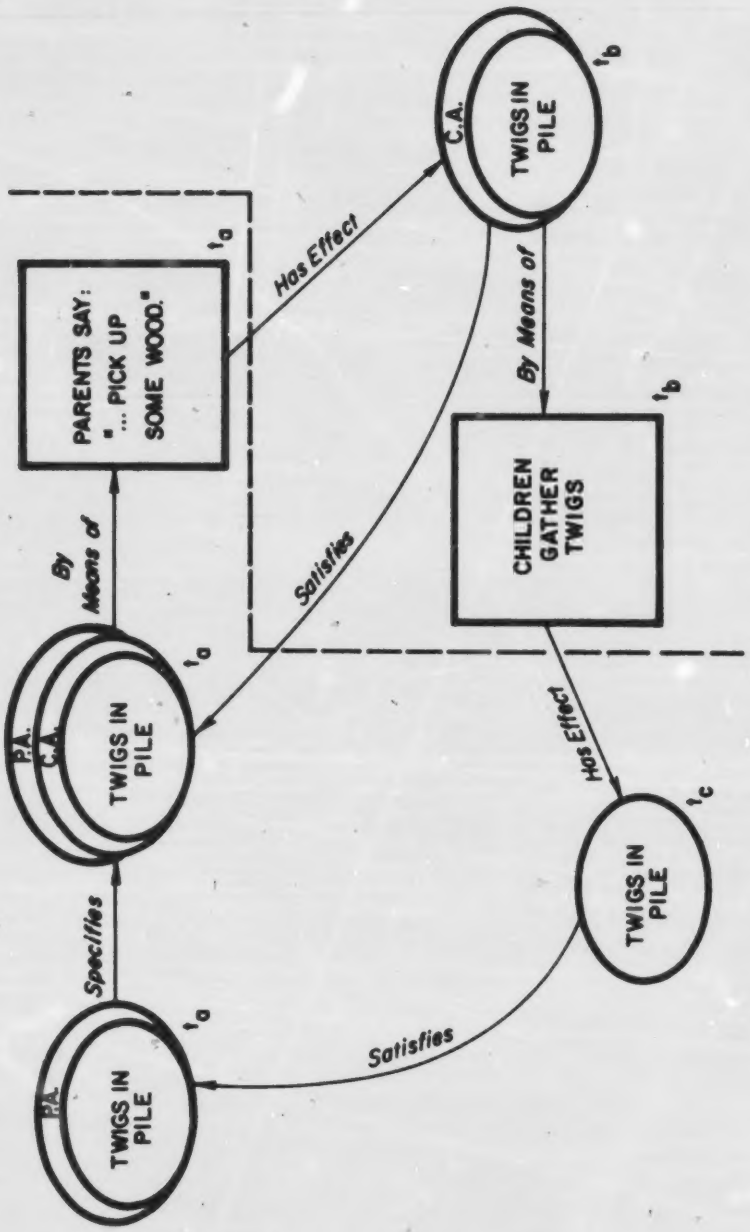


Figure 37. A simple interacting plan: Requesting help from the children



represented as an intention by the parents to achieve the state of a pile of twigs existing. In another situation this goal might be achieved by going about gathering twigs. But here, the parents choose to get the children to perform the necessary actions. Thus, we have an elementary interacting plan. The intention to achieve a pile of twigs is changed into an intention to achieve an intentional state in the children. This new goal is achieved by means of saying to the children, "Now, children, pick up some wood. I want to make a fire to warm you." This, of course, is a request and it has the effect of the children having the intention to achieve a pile of twigs by means of gathering twigs. This action satisfies the parents' intention to have a pile of twigs and satisfies the enabling condition for their building a fire. Notice that while the parent's intention to have twigs in a pile is present at time a, the children's intention comes into existence at time b, only after the parent's request.

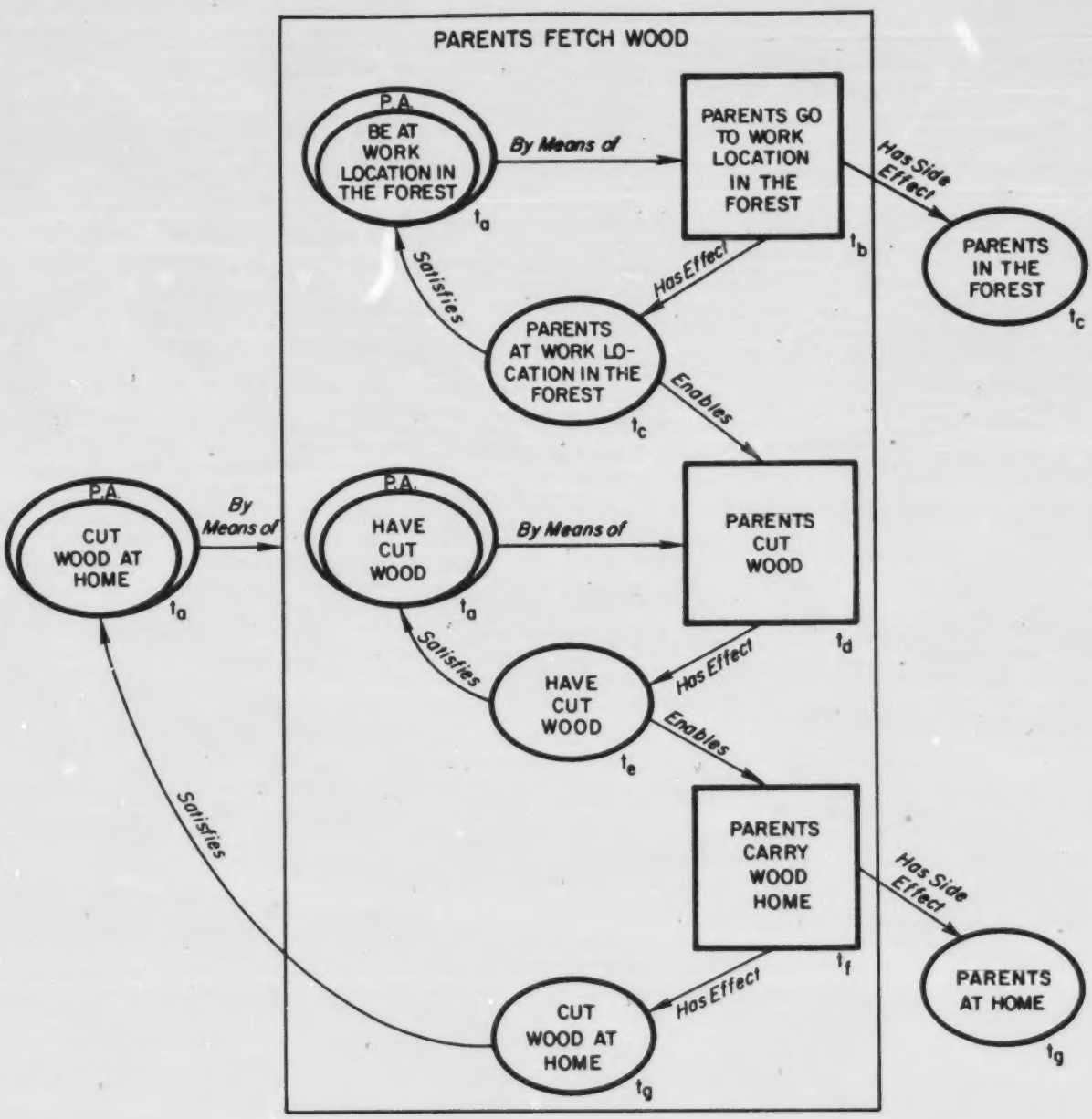
3.4 Achieving Multiple Goals

The fire building plan illustrates one of the basic configurations used to represent interacting plans. We can now begin to lay out some of the basic structures of the parent's full plan. We will first show how to represent an ordinary wood fetching episode, which, we assume, is commonly carried out without any malevolent intent, and is well known by the parents and children. Then, we will show how the parent's plan to get rid of the children is an attempt to use the children's cooperation in an ordinary episode.

Figure 38 shows the parents' procedure for fetching wood from the forest. The intent to have a supply of cut wood at home is achieved by means of the higher level act of fetching wood which itself is accomplished by doing the three lower level acts of going to the work location in the forest, cutting wood and then carrying it home. We can consider this structure to be like a basic script for fetching wood that can be carried out regardless of whether the children come along on the outing. (In subsequent diagrams, this basic structure is abbreviated using the ByDoing relation between the acts.) In the representation of the parent's plan, this script maintains its integrity since we assume that the parents know this procedure independently of its application on a particular occasion, when consideration must be given to particular contingencies that may arise.

The script itself has ramifications that affect other intentions the participants may have. For example, going to the work location has the side effect that the the parents are in the forest. As we shall see, this effect has consequences with regard to other intentions of the parents represented in Figure 39. Figure 39 shows another set of parents' intentions: those involved in caring for the children. These intentions are a basic part of an ordinary (benevolent) wood fetching episode, which we are representing now before going on to show how the same plan can be used malevolently. The general intention to maintain a state of the children being cared for can be further specified by the intentions to maintain the state of the children being out of danger and to maintain their being nearby. We can

Figure 38. The parents' wood fetching plan



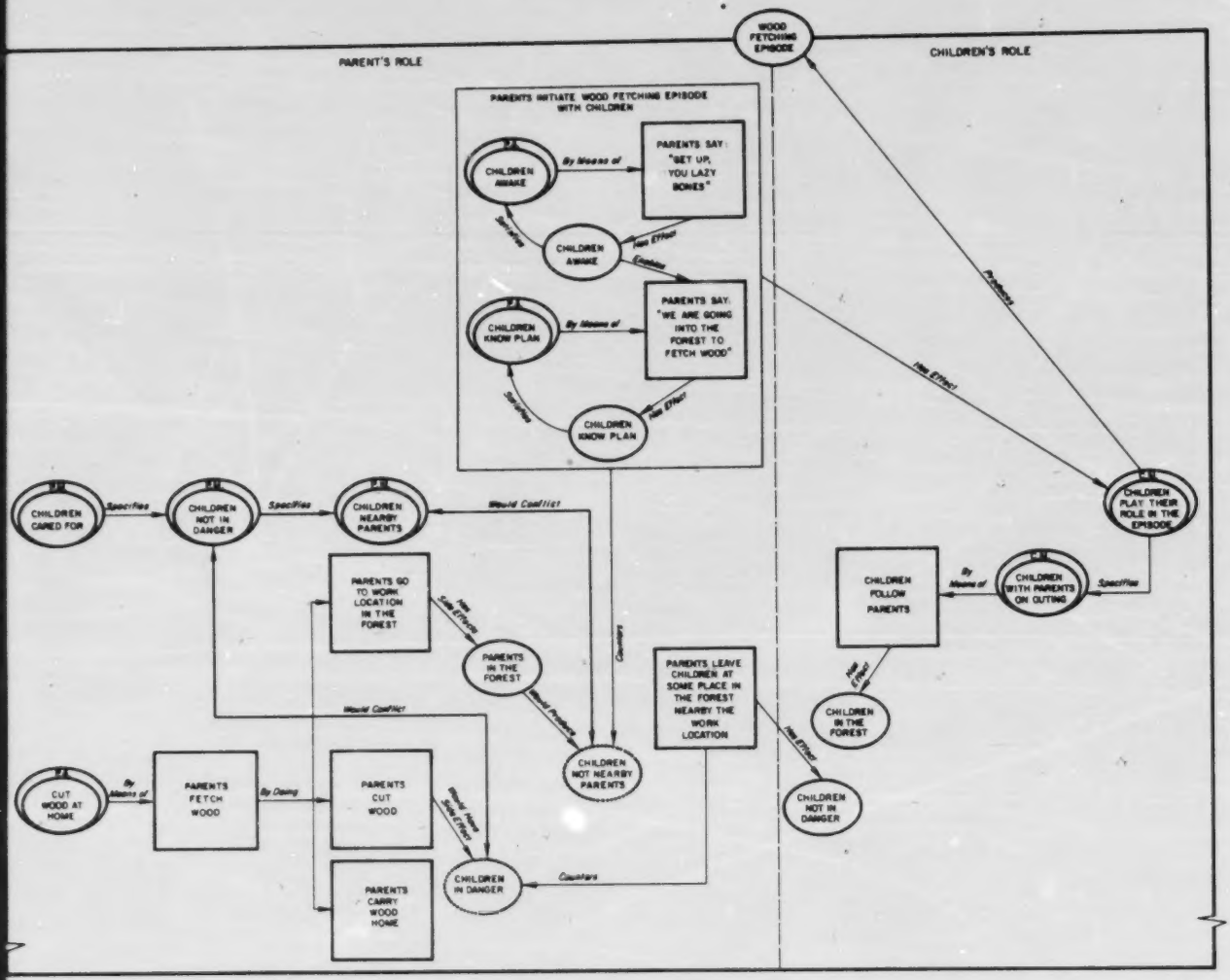


Figure 39. Achieving multiple goals

consider first the parents' intention to keep the children near them.

There is a critical belief shown in Figure 38 which interacts with the intention to stay near to the children. The fact that the work location is in the forest means that the parents will be in the forest and therefore not near the children when they go to work. If we turn now to Figure 39, we can see that the state of being in the forest would produce the state of the children's not being near the parents which, in turn, would conflict with the intention to maintain nearness to the children.

Figure 39 illustrates an important configuration which arises when two intentions have to be coordinated (cf. Waldinger, 1975). Maintain intentions are often inactive as long as the state that is their goal is in existence and not threatened. When other plans are being formulated, however, the Maintain intentions may act as critics which survey the plan for conflicts. In the case of fetching wood, a possible conflict was found and the Maintain intention specifies a way to avoid the conflict, namely to take the children on the outing. The state in the dotted oval (Children not nearby Parents) is a hypothetical state since it never actually occurs but is intended to be countered by an action which is consistent with the plan to fetch wood. The way in which the conflict is avoided is rather complex but follows the general pattern of the request illustrated in Figure 37 (and in Figure 27).

3.5 Initiation of a Social Episode

> At daybreak, before the sun had risen, the woman came and said, "Get up, you lazybones! We are going into the forest to fetch wood."

The intention to maintain "nearness" leads to an action that counters the state of the children being left at home. The parents want to maintain a state of the children being along on the outing which is done by getting the children to have the intention to be on the outing. But the outing is not something the children can do on their own (like gathering twigs); it is essentially a shared undertaking, or social episode, in which the participants have recognized roles. Thus getting the children to have the intention of being on the outing is not done by a simple request but by initiating an episode. The children's following, which serves to maintain proximity to their parents, assures that they will be in the forest with the parents (and back home at the end of the episode.)

The parents' act of initiation is a complex act (near the top of Figure 39) which contains two smaller actions. The first action is intended to wake the children up. The second act describes the plan: "We are going into the forest to fetch wood." The complex act has the effect that the children intend to maintain their role in the episode. Their intention (in combination with the fact that the parents intend there to be an episode) produces a state of mutual belief concerning a shared course of action. This state (the episode) is indicated at the top of Figure 39 and by the large square that now surrounds the

whole course of action. Placing the course of action in an episode means that it is mutually recognized or believed that the participants will perform their respective roles. The parent's announcement of the plan can produce this effect because going to fetch wood with the children along is an ordinary and commonly occurring event for which the participants know what each other will do. (Figures 39 and 40 are slightly abbreviated in that the parents intention to maintain the episode is not shown).

The children's role as indicated on Figure 39 is clearly reactive to the parents' initiations. In addition, the role for the children involves only following the parents. The other actions they perform are done in response to specific requests from their parents.

3.6 Modification of the Basic Script

> ... the woman said, "Now lie down by the fire and rest yourselves while we go and cut wood. When we have finished we will come back to fetch you."

As will be seen in figures 39 through 42, the basic script for fetching wood can be modified to integrate it with the intentions to care for the children. We have seen that a conflict between a side effect of fetching wood and the intention to remain nearby the children leads to an act that counters the undesirable state. This action of initiating the episode can be seen at the top of Figure 40 as specified directly by the intention to stay nearby. It becomes part of the ordinary sequence involved in going out to fetch wood when the children have to come along. Going back to Figure 39, another conflict

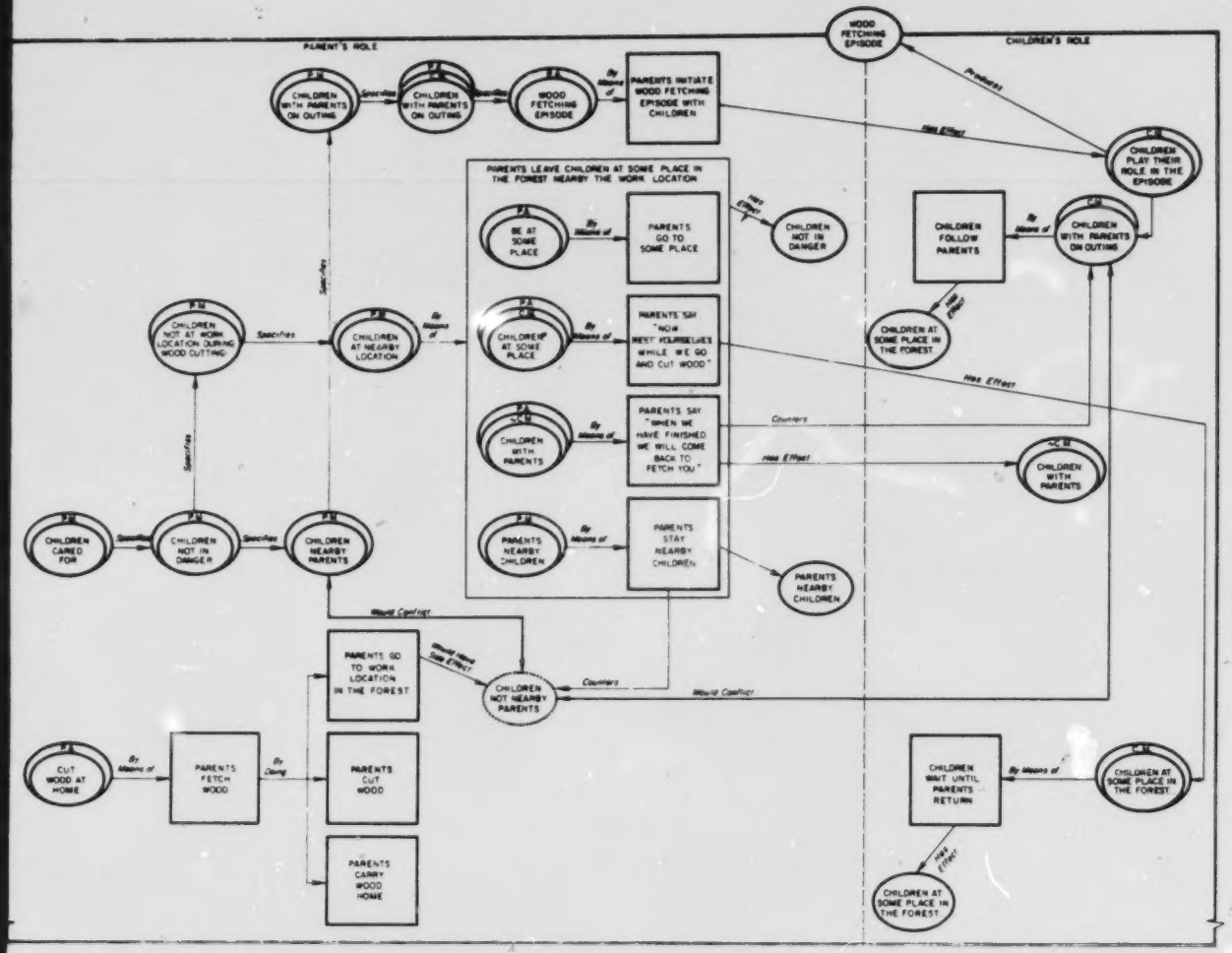

WOOD FETCHING EPISODE
PARENT'S ROLE
CHILDREN'S ROLE
CHILDREN WITH PARENTS ON OUTING
CHILDREN WITH PARENTS ON OUTING
WOOD FETCHING EPISODE
PARENTS INITIATE WOOD FETCHING EPISODE WITH CHILDREN
CHILDREN PLAY THEIR ROLE IN THE EPISODE
PARENTS LEAVE CHILDREN AT SOME PLACE IN THE FOREST NEARBY THE WORK LOCATION
BE AT SOME PLACE
PARENTS GO TO SOME PLACE
CHILDREN NOT IN DANGER
CHILDREN FOLLOW PARENTS
CHILDREN WITH PARENTS ON OUTING
CHILDREN NOT AT WORK LOCATION DURING WOOD CUTTING
CHILDREN AT NEARBY LOCATION
CHILDREN AT SOME PLACE
PARENTS SAY "NOW MEET YOURSELVES WHILE WE GO AND CUT WOOD"
CHILDREN AT SOME PLACE IN THE FOREST
PARENTS SAY "WHEN WE HAVE FINISHED WE WILL COME BACK TO FETCH YOU"
CHILDREN WITH PARENTS
CHILDREN CARED FOR
CHILDREN NOT IN DANGER
CHILDREN NEARBY PARENTS
PARENTS NEARBY CHILDREN
PARENTS STAY NEARBY CHILDREN
PARENTS NEARBY CHILDREN
PARENTS GO TO WORK LOCATION IN THE FOREST
CHILDREN NOT NEARBY PARENTS
CUT WOOD AT HOME
PARENTS FETCH WOOD
PARENTS CUT WOOD
PARENTS CARRY WOOD HOME
CHILDREN WAIT UNTIL PARENTS RETURN
CHILDREN AT SOME PLACE IN THE FOREST
CHILDREN AT SOME PLACE IN THE FOREST
Specifies
By Means of
By Doing
Has Effect
Would Conflict
Counters
Produces

Figure 40. Initiating the social episode

can be seen, namely between the intention to keep the children out of danger and the possible side effect of the children being in the immediate vicinity of the actual wood cutting (with swinging axes, falling trees etc.). The parents can resolve this conflict by leaving the children at some place other than the work location. Turning again to Figure 40, this action can be seen now as directly specified by the intention to keep the children out of danger. But now leaving the children to go cut wood conflicts with being near them. So another action is added (within the complex act of leaving the children) that prevents the conflict. This action by the parents (Parents stay nearby Children) means that now the parents take the responsibility for maintaining adequate proximity to the children.

The complex act of leaving the children is a set of actions, the outcomes of which, in combination, produce the effect of the children's being out of danger of swinging axes etc. One of the actions within the complex act counters the children's intention to stay with the parents (which led to following) and another of the actions produces in the children a new intention to stay at the place where they are left.

All goes well with the ordinary wood fetching episode until, as seen on Figure 41, the parents start to carry the cut wood back home. Since now the children are in the forest, this would conflict with the intention to stay near the children. Thus a new action is added in which the parents go back and fetch the children. As seen on Figure 42, this action has the effect of turning off the children's intention to stay at the place they

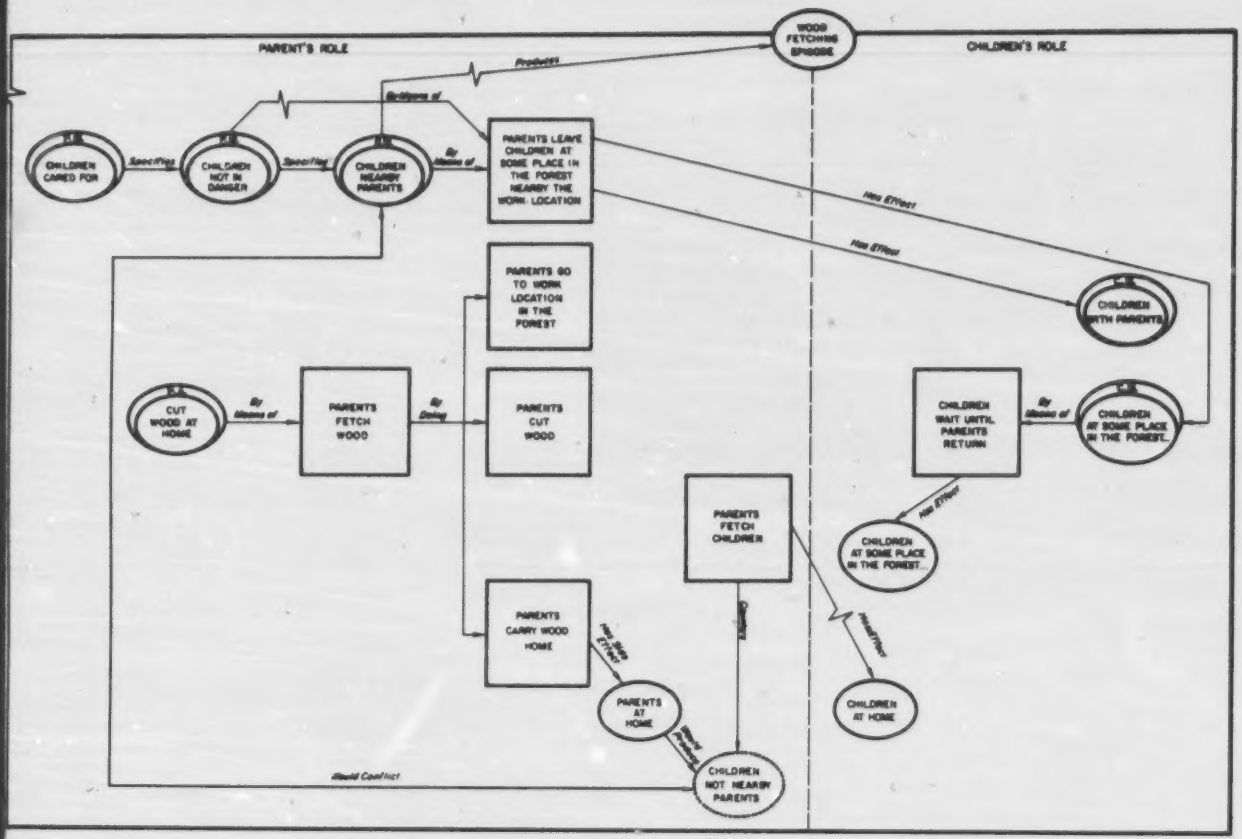


Figure A1. Modifying a script - I

were left and to reinstate the intention to stay with the parents. The children then follow the parents home and the ordinary episode is over.

The conflicts and the modifications to the basic script that are illustrated in figures 39 through 42 show how different goals can be coordinated. They are not intended to represent the actual process that might be involved in planning such an episode. We assume that the full (ordinary) shared episode script would have been built up over time so that the final full sequence is itself a script that is known by the participants. To understand the plan that the parents have to get rid of the children, however, it is necessary to see the basic wood fetching script as independent from the script for the ordinary wood fetching episode which includes a role for the children. The parents' deceptions involve only the part of the script that is generated from the intentions to care for the children. We can now turn to the parents' real plan.

3.7 Embedding of the Virtual Plan

> One night when he lay in bed worrying over his troubles, he sighed and said to his wife, "What is to become of us? How are we to feed our poor children when we have nothing for ourselves?"
>
> "I'll tell you what, husband," answered the woman. "Tomorrow morning we will take the children out quite early into the thickest part of the forest. We will light a fire and give each of them a piece of bread. Then we will go to our work and leave them alone. They won't be able to find their way back, and so we shall be rid of them."
>
> ***
>
> Hansel and Gretel sat by the fire, and when dinnertime came they each ate their little bit of

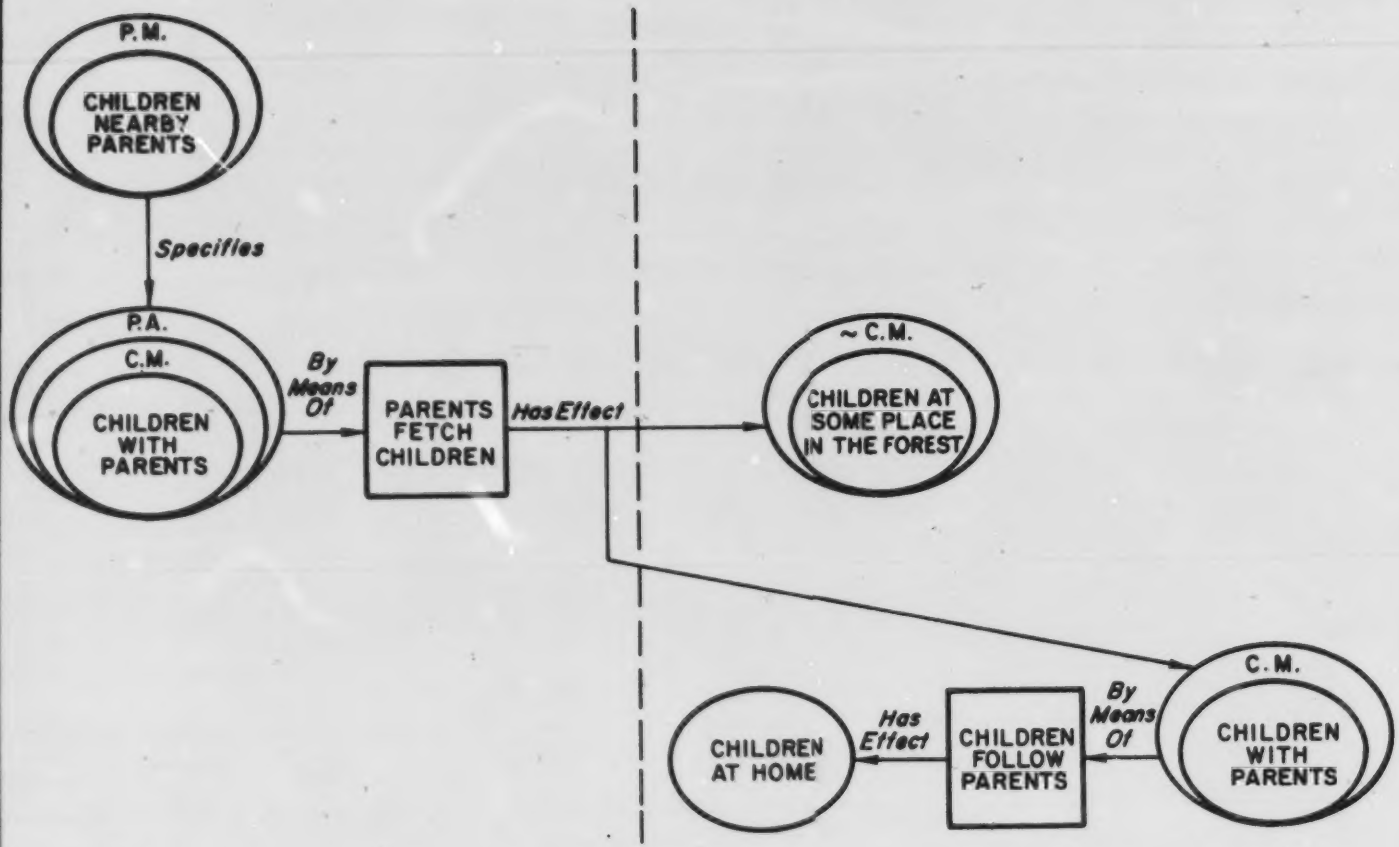


Figure 42. Modifying a script - II

> bread, and they thought their father was quite near because they could hear the sound of an ax. It was no ax, however, but a branch which the man had tied to a dead tree, and which blew backwards and forwards against it. They sat there so long that they got tired. Then their eyes began to close and they were soon fast asleep.

The interactive plan represented in Figures 39 through 42 is never actually carried out in the story, at least not in full, and certainly not with the intentions indicated for the parents. The plan is actually a virtual plan that the parents want Hansel and Gretel to believe is being carried out. In order to represent the parents' actual view of the interactive situation, it is necessary to show how they intend to use the children's belief in this plan to achieve their real intention to get rid of the children by causing them to be lost in the forest.

The parents depend on the children's belief that it is an ordinary wood fetching episode to get the children to follow them into the forest. They also depend on the children's intention to wait in the nearby location so that the children do not follow them back out of the forest. In the actual plan, the critical lie occurs when the stepmother says to the children: "Now lie down by the fire and rest yourselves while we go and cut wood. When we have finished we will come back to fetch you." It is only by understanding what the ordinary sequence of events is in such a situation that it is possible to understand how the stepmother's statement produces the desired effect of leaving the children behind.

Figure 43 represents the basis of the parents' real plan as it relates to the episode that they want the children to believe is legitimately taking place. The parents' real intentions are represented on the far left. Basically they want to have enough food for themselves and this requires that they get rid of the children by leaving them in the forest where they would be eaten by wild animals, witches or other things that live there.

> "Nay, wife," said the man, "we won't do that. I could never find it in my heart to leave my children alone in the forest. The wild animals would soon tear them to pieces."
> "What a fool you are!" she said. "Then we must all four die of hunger. You may as well plane the boards for our coffins at once."

The real action they perform is to lose the children in the forest. Notice that each of their real intentions conflicts with one that the children could be expected to infer from their actions, given that the children believe the actions to be taking place in a shared episode. Notice also that the intention to have a supply of cut wood at home is independent of the intention to get rid of the children. (In fact, the stepmother says to the father "Then we will go to our work and leave them alone". The parents actually intend to do their work.)

Figure 44 shows the parents' real plan in more detail. It can be seen that each of the actions in the episode is either real or virtual. Many of the actions within the episode are also specified by intentions in the real plan. These are marked by the SameAs relation. Going to a place in the forest (in the episode) is filled in (in the real plan) by going to the

Figure 43. The parents' real intentions

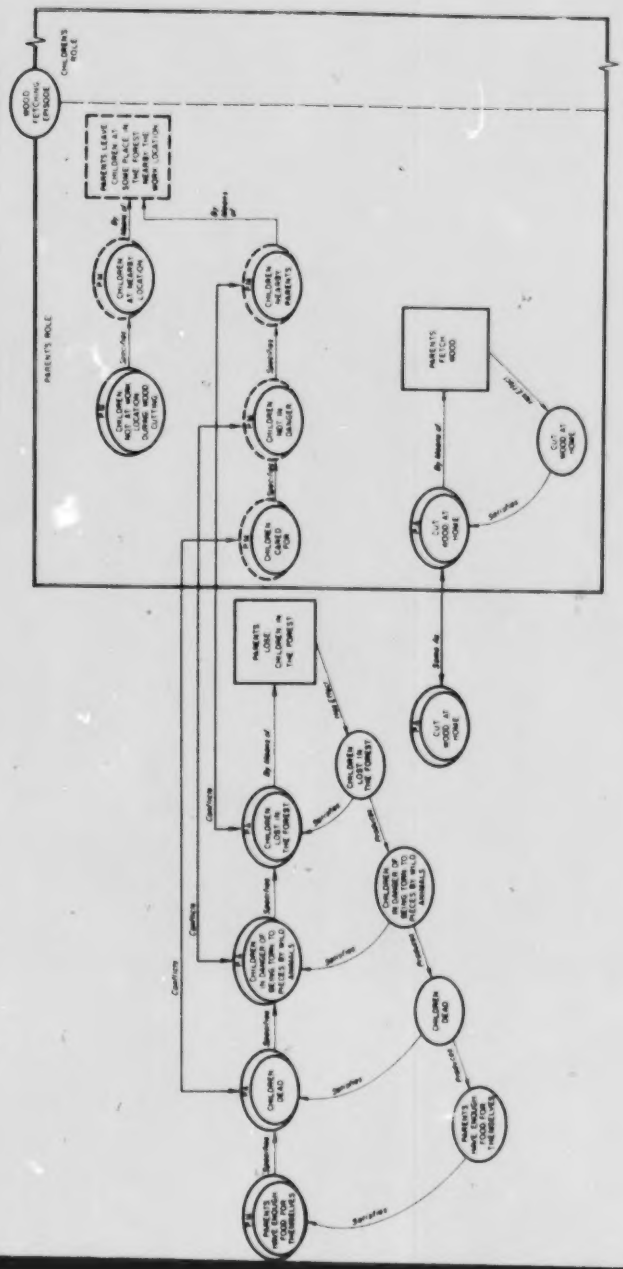
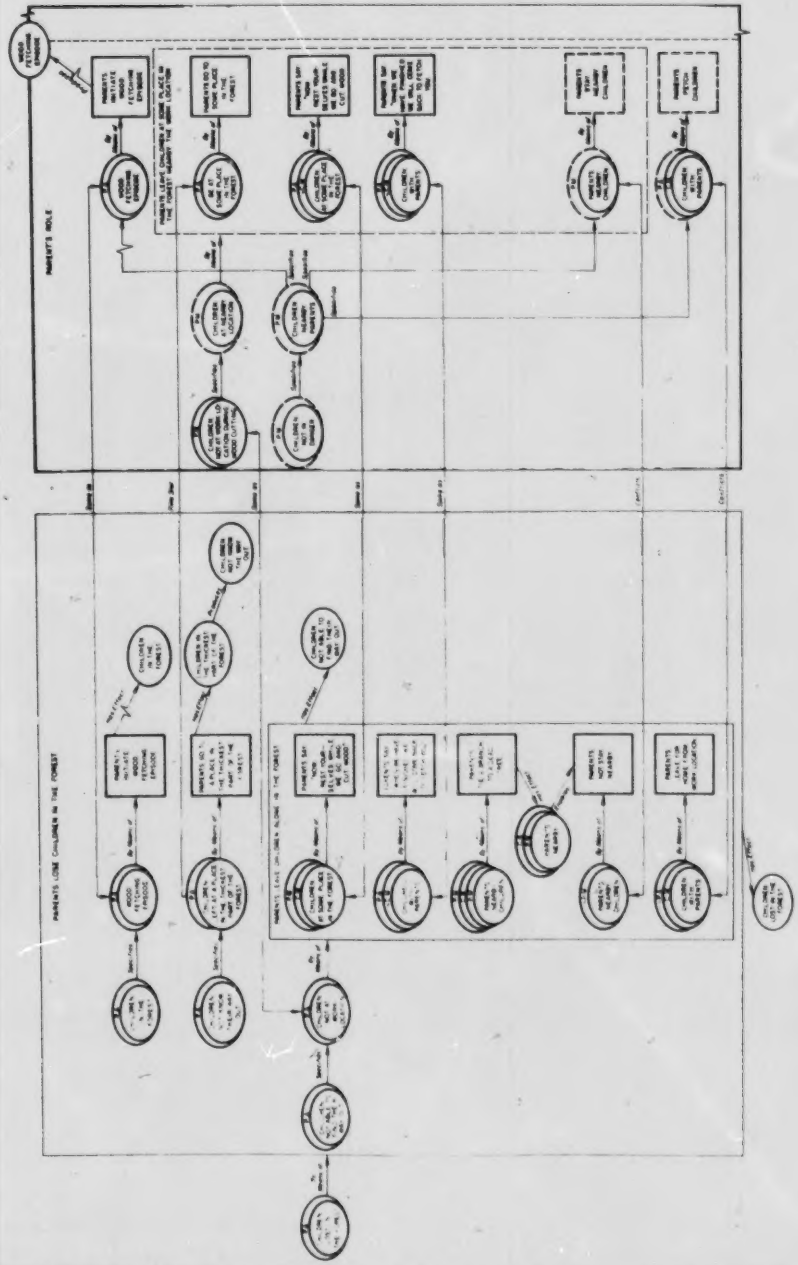


Figure 44. The parents' real plan



thickest part of the forest. The critical conflicts concern the parents' intention to stay nearby and to return to fetch the children. The complex act "Parents lose Children in the forest" itself contains a complex act of leaving them in the forest alone. Given that the children are in the thickest part of the forest, leaving them alone would give them no way of finding their way back. Thus the children would be lost.

3.8 Acting on an Interacting Plan

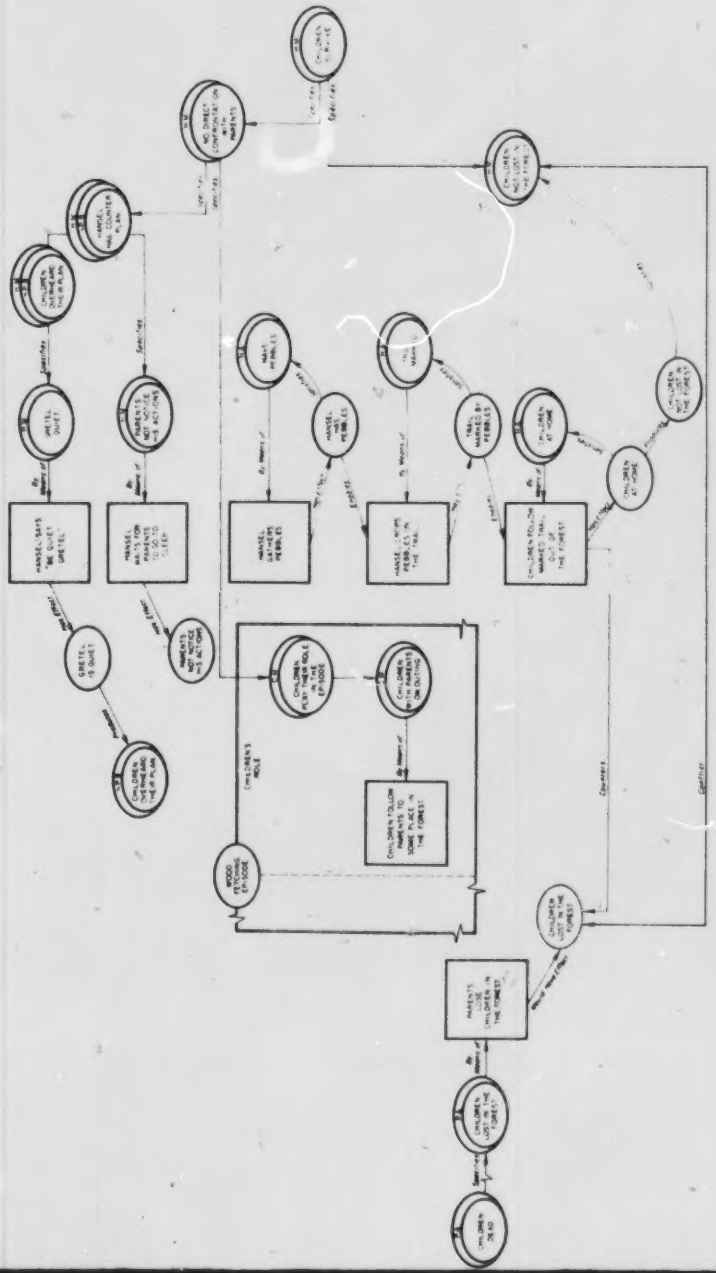
> She gave him no peace till he consented. "But I grieve over the poor children all the same," said the man. The two children could not go to sleep for hunger either, and they heard what their stepmother said to their father.
>
> Gretel wept bitterly and said, "All is over with us now."
>
> "Be quiet, Gretel," said Hansel. "Don't cry! I will find some way out of it."

The parents are not the only ones who have concealed intentions, for the children are also carrying out a plan. Their plan is intended to block the effect of the parents' real plan by finding an alternative to following that would get them out of the forest. In Figure 45, we attribute the children's plan to Hansel since he apparently has a richer understanding of both the virtual plan and its use in the real plan of the parents. It is he who gathers and drops the pebbles, and it is he who comforts the frightened Gretel.

The children also pretend to be participating in an ordinary wood fetching episode. Presumably it is necessary that they avoid direct confrontation with the parents for fear that the parents would otherwise take more drastic means to get rid of

F

Figure 45. Hansel's real plan



them. Hansel's method of blocking the parents' plan is so skillfully executed, in fact, that the parents never find out that he and Gretel know that the parents are plotting against them. Hansel, for example, tells Gretel: "Be quiet, Gretel" so that the parents will not discover that the children had overheard them plotting. It is just as important for Hansel's plan as it is for the parents' plan that the ordinary episode be carried off as if it were the real plan.

Figure 45 shows Hansel's real plan. His intention to survive specifies both that he avoid direct confrontation and that he find a way of getting out of the forest. Thus he plays a role in the episode, not because he is deceived into thinking that it is an ordinary episode, but in order to avoid a more direct showdown with the parents in which he might be the loser.

For both the children and the parents, the virtual plan is embedded in the real plan. For the parents it is a straightforward deception (or attempt at a deception). For Hansel, there is an additional embedding. His real plan contains a representation of the parents' real plan, which in turn includes their use of the virtual plan. As is evident from "Hansel and Gretel", deceptive plans often make use of ordinary plans. The representation of deception, then, becomes a special case which requires the representation of ordinary plans as a groundwork.

3.9 Separate Realities

One of the things that makes the first episode of "Hansel and Gretel" intriguing is that the characters have different views of what is happening. Each view (or view of a view) is a belief space, which can be categorized by who maintains the view. For example, there is the belief space that contains the parent's beliefs about the children's beliefs.

We take advantage of the notation proposed by Cohen (1978) to indicate these representational spaces. Each diagram in the preceding analysis can be interpreted as being within a particular space, or spaces, since we are assuming no absolute facts, only beliefs. For example, Figure 46 shows that state X is believed by A but that A believes B believes the opposite.

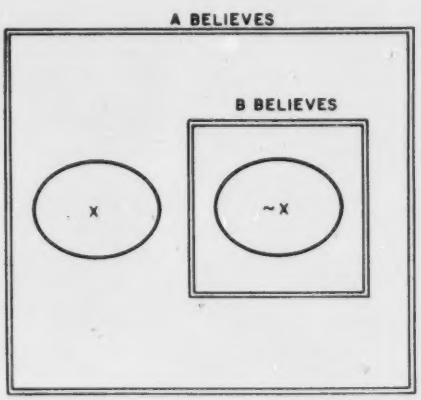


Figure 46. Differing beliefs

One special representational space needs to be singled out. This is a mutual belief space, which indicates that from the point of view of the target character, states contained within

are believed, and believed to be believed. For example, if A believes that both A and B believe X, and that both A and B believe that A and B believe X, and that both A and B believe that both A and B believe that A and B believe X, and so on, then we say that A believes that A and B mutually believe X, or MB(A,B). Cohen discusses mutual belief spaces further and gives a finite representation scheme for the indefinite recursion they imply. For our purposes, we will simply indicate when a space is a mutual belief space. Note that since no beliefs are necessarily shared, MB(A,B) may not be the same as MB(B,A). (i.e., while A may believe that A and B mutually believe X, B may not believe it.)

We can symbolize the various belief spaces as follows:

XB X believes that ...

MB(X,Y) X believes that X and Y have a mutual belief that ...

where X and Y indicate either the parents (P) or the children (C).

Since we are discussing the belief structures contained within stories, we also want to be able to represent the reader's beliefs which are often different from at least some of the characters'. Some stories may be written to give the reader initially a false belief (only later in the story does the reader realize that one character had been right all along.) We use RB to indicate the reader's beliefs. But to simplify matters let us assume that the reader has a "true" understanding of the first part of "Hansel and Gretel". Then we can omit the explicit

indication of RB in front of every belief space. Some of the important belief spaces then become:

PB The parents believe that ...

PBCB The parent's believe that the children believe that ...

MB(P,C) The parents believe that they and the children have a mutual belief that...

CB The children believe that ...

CBPB The children believe that the parents believe that ...

MB(C,P) The children believe that they and the parents have a mutual belief that...

We can summarize the intrigues in the story in terms of such belief spaces: The parents have both a real plan to kill the children (in PB) and a virtual plan that they intend to have the children believe. Since they believe that they are succeeding, the virtual plan enters PBMB(C,P), and therefore, PBCB. The part of the virtual plan that is true for the parents goes into MB(P,C). Note that intentions of caring for the children are in PBMB(C,P) but not MB(P,C), whereas more reality based facts such as being in the forest are in both PBMB(C,P) and MB(P,C). The children (i.e., Hansel) have their own plan, in CB. They accept part of the virtual plan, in MB(C,P) but reject part of it.

This would get quite complicated were it not for the assumptions that in overhearing his parent's plans, Hansel gains complete knowledge and that this knowledge matches that of the implied reader. Thus several of these belief spaces turn out to

be congruent. In fact, there are only four equivalence classes of spaces as shown in Figures 47 through 50. These spaces are the following:

1. The virtual plan (Figure 47): This is what the parents think they have induced the children believe. It is thus PBCB, and since the episode is supposed to be shared, PBMB(C,P). Since Hansel sees through the virtual plan it is also CBPBCB and CBPBMB(C,P).

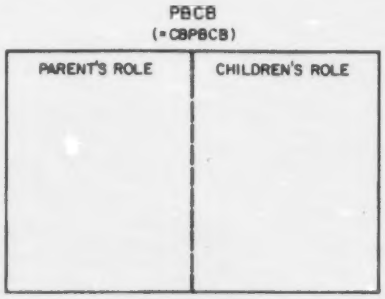


Figure 47. The virtual plan

2. The parent's beliefs (Figure 48): This includes the parent's real plan. Since Hansel knows their plan this space is both PB and CBPB.

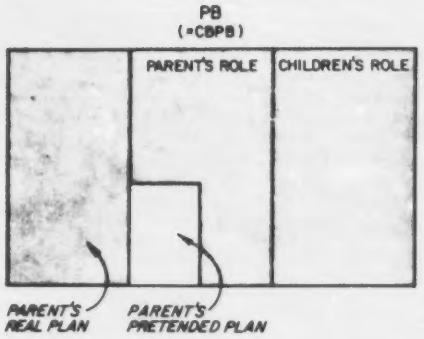


Figure 48. The parents' beliefs

3. The children's beliefs (Figure 49): This includes the children's real plan. It is only CB since the parents do not know the children's real plan. Since the children do have all the facts this also is the same as RB (the reader's beliefs).

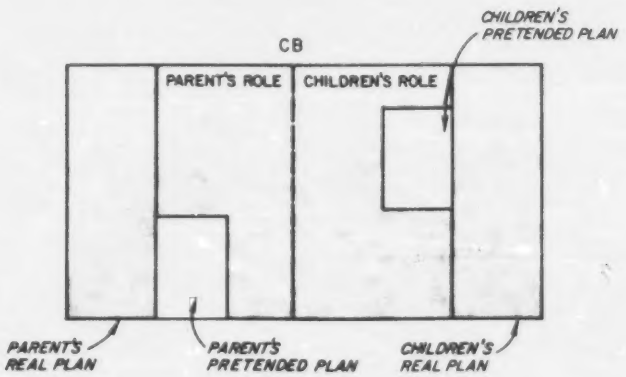


Figure 49. The children's beliefs

4. Coinciding mutual belief (Figure 50): Items that are in the intersection of MB(P,C), MB(C,P), i.e., things which everyone

accepts and everyone believes are mutually accepted. This is included in each of the above. Note that this space, under ordinary circumstances, would include the entire shared episode but is reduced in size here because of the deception engaged in by both participants. In ordinary cooperative interaction MB(X,Y) and MB(Y,X) would be congruent. Our term "coinciding mutual belief" corresponds to Schiffer's (1972) term "mutual belief".

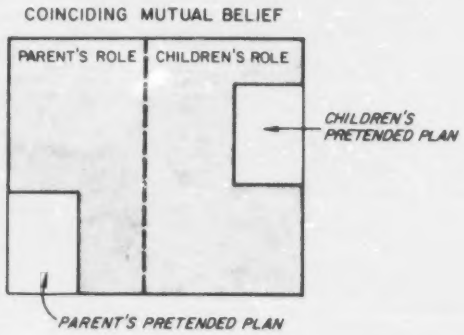


Figure 50. Coinciding mutual beliefs

4. Limitations of the Representation

Undoubtedly the least controversial feature of the representation presented here is that it is complicated. We believe that this complexity is necessary because social interaction of the kind described in "Hansel and Gretel" is itself complex. The intricacy of the representation needed just to account for the story as related in the text has been a surprise even to us.

But what we have discussed here is only a sketch. There are several ways in which we have had to simplify the representation (aside from the trivial means of abbreviating, e.g., the ByDoing relation).

4.1 Combined Participants

As mentioned earlier, we combined the father and the stepmother into a single character called "the parents", and combined Hansel and Gretel into a character called "the children". This makes it impossible to represent important aspects of the episode. For example, our abbreviated representation does not allow us to distinguish between the father, who loves the children (but not enough) and the stepmother who sees them as additional drains on the family's limited resources. Their intentions are clearly differentiated in the story and could be represented formally with additional diagrams representing their initial conversation as a plan of the stepmother to convince the father. Our two dimensional system, does not, however, allow us to represent more than two plans simultaneously.

4.2 Point of View

The diagrams show the virtual plan as equivalent from each point of view. A complete representation would require a view for each of the characters. For this particular case it may not be wrong to assume that wood fetching is a familiar activity to the family, familiar enough that most beliefs are shared, that is, believed by all participants, believed to be believed by all

participants, and believed to be believed to be believed by all participants. Thus, the parents' view is of a shared plan that is not markedly different from the children's view. This works for the wood fetching episode as an ordinary plan episode but not when wood fetching serves as a virtual plan.

4.3 Changes Over Time

We have also limited our discussion of how plans change while events are occurring. A complete representation of the plans discussed here would require a complete set of diagrams for each time point in the episode. Attempting to represent all of the virtual plan at a single point forced us to adopt the simplifying assumption that the parent's intentions and the consequences of their actions are known in full to the parents at the time that they initiate the episode. A more reasonable assumption is that some of the detailed intentions and planned acts arise as events occur.

4.4 The Process of Planning

The diagrams here emphasize the end result of planning, i.e., a plan. We have limited our examples that would show how an interacting plan might be formulated. However it would be important to consider the process since it is in planning that solutions to conflicts are created and compared. The representation of this process would require considerably more apparatus than we have so far developed.

Plans are rarely formulated in advance. Instead, they typically consist of a goal and some loosely defined expectations

about how the goal might be attained. But a full representation of such changing expectations would not be enough, for our purposes, where there is not one, but a set of (interacting) plans, and the state of any plan is dependent upon the actions determined by the other plans. Furthermore, the re-actions from the other plans may be quite unpredictable (since they depend as much upon the goals of those plans as upon external events). A plan must therefore be sensitive to the actions of other plans, and our representation must reflect this inter-dependency.

But that is only the beginning of the problem. Each plan, in order to react appropriately to the actions of other plans, may build a model of any other plan. As actions unfold, the model may have to be revised. A plan, which is itself being formulated during execution, is re-formulating its model of the other plans. On top of that, it "knows" that the other plans have models of it, and that often an effective way to achieve a goal is to affect the others' models. Eventually we would want to be able to represent an individual's process of planning, but also the social process of formulating a shared plan in the course of interactions with others.

4.5 Use of the Episode in the Story

A representation that was complete on each of the dimensions discussed above would still be a representation of only a small part of "Hansel and Gretel". One could even view the entire set of actions as merely used to set the stage --- to explain how two children get lost in the woods.

Despite these limitations the analysis as done tells us several things. It demonstrates the possibility of a consistent analysis of plans that interact. It illuminates areas of investigation that might otherwise be ignored. It shows that one can give a more precise meaning to terms such as "conflict" and "intention", terms which are familiar to humanistic analysis of literature, if not to scientific analysis of text.

5. Complexities - Easy vs. Hard Texts

A formal plans analysis demonstrates that even apparently simple stories may require complex plans representations. But beyond the simple demonstration that interacting plans can be complex, our method of analysis allows us to be more precise in measuring the relative complexity of stories along several dimensions. Whether or not differences along the dimensions we outline here make a difference for comprehension or recall is, of course, an empirical question. It also remains for empirical work to show in what ways these dimensions interact with each other or with other factors such as age, reading experience, or medium of presentation. We can begin by outlining eight possible sources of complexity. We then suggest some hypotheses about why and how these dimensions may lead to difficulty in comprehension. Following that we discuss some implications of these factors for teaching reading and selecting texts for children.

5.1 Complexities that become measurable with the representation system

The following dimensions are a source of hypotheses about what may make interactive plans difficult to understand. Any two or more texts that are analyzed by means of the system of representation may be compared directly along these dimensions.

5.1.1 Size of Plan

A plan may involve a long sequence of acts or may be accomplished by a single act. The temporal duration of the plan may also be a factor.

5.1.2 Changes in Plans

Plans in a story can remain fairly constant or may change in response to events occurring during the plan's execution. The number and magnitude of changes may be a source of difficulty.

5.1.3 Degrees of Interaction

When there are multiple actors in a story, their plans can be more or less interconnected, Hansel and Gretel's plans are tightly intertwined with their parents' plans. Each is trying to respond to the others and to get the others to do an act in a particular way. In other stories characters' plans may not interact as tightly or there may be only one character.

5.1.4 Conflicts

The number and types of conflicts among plans in a story may also be a source of complexity. It is not necessarily the case, however, that plans of any type can conflict with plans of any

other type. In fact, the identification of types of plans leads us to an identification of types of conflicts that arise among plans in interactive situations.

5.1.5 Embeddings

Interacting plans may contain multiple embeddings of beliefs within beliefs, e.g., A believes B believes A believes X. They may also contain embedded intentions. For example, Hansel and Gretel's parents intend the children to have the intention of following them into the forest. A consequence of the embeddings of beliefs and intentions is that one plan can be defined with reference to other plans, and those to yet other plans. Hansel's plan is formed with reference to the parents' plan which, in turn, contained a plan the children were supposed to have. There may be stories with more embeddings than this but there may be a limit to the number of embeddings that can be comprehended (or even written about).

5.1.6 Levels of Characterization of the Same Action

The notion that acts can be described at a variety of levels, none of which can be reduced to the lower level description, in not a new notion in philosophy or psychology, but it is to formal models of plans and planning. One reason is that most of the formal work on plans has focused on planning in artificial situations. But in analyzing human interactions, it becomes not only helpful but necessary to make explicit these different levels of characterization for the same act. For example:

Levels of Characterization

Surface Level	Deep Level
slipping a ring on a finger	getting married
walking across the street	jay-walking
saying "Hello"	a greeting

The same action can be viewed at various levels or clumped together with other actions. Clearly, there can be many levels of characterization for the same act or sequence of acts (cf. "perspectives" in KRL, Bobrow & Winograd, 1977). We have represented higher level characterizations in terms of various kinds of complex acts. An important aspect of interacting plans is that people develop them and carry them out in the context of their perceptions of others' actions. Two characters may understand the same action in different ways or as part of different sequences. For example, the plan of Hansel and Gretel's parents, (Figure 44) their action of telling the children to wait is part of the complex act of leaving the children alone in the forest but in the sequence as it was supposed to be perceived by the children it is part of the complex act of having the children wait at a safe place.

5.1.7 Beliefs Outside of the Mutual Belief Space

In an ordinary cooperative episode most beliefs are held mutually by the characters. The reader can then assume that all knowledge is transparent to all. Often, though, the reader must assume that there are beliefs outside of the mutual space, not

necessarily conflicting beliefs, but beliefs that are not known to one or more characters.

5.1.8 Virtual Plans

Virtual plans are an important special case of beliefs outside of the mutual belief space. In a virtual plan, what A knows but B does not is that certain critical elements in what B believes is the mutual belief space are actually false. The mutual belief space is being used by A to cover over A's real intentions (that lie outside the space). Virtual plans work because by themselves they constitute a coherent course of action. The character is acting on the basis of a real plan (outside of the mutual belief space), but puts forward the virtual plan as an alternative explanation for his or her actions.

Virtual plans are common in stories. Hansel and Gretel's parents use the virtual plan of ordinary wood fetching to pursue their real plan of getting rid of the kids. In fact, the following outline appears to be a good model for a large class of stories. It defines a kind of deception wherein characters act on the basis of real plans, but pretend to act on the basis of virtual plans.

Outline of a Typical Story Containing
a Virtual Plan

1. A has a problem that suggests a goal that is in conflict with a goal of B.
2. A realizes that B's normal actions (or inactions), i.e., B's real plan, will not help in achieving the goal.
3. A further realizes that B will not alter his plan to suit A's goals.
4. A therefore puts forth a virtual plan either to conceal A's real plan, or to entice B into doing something he would not otherwise have done.
5. B responds to the virtual plan. In some cases he falls for the trap, e.g., in Aesop's fable of "The Fox and the Crow" the crow sings in response to flattery and drops a piece of meat. In other cases, B sees through the virtual plan to A's real plan, then pretends to go along with the virtual plan, or puts forth his own virtual plan.
6. Actions proceed, but each action has alternate simultaneous interpretations, as part of the virtual plans and as part of the real plans.
7. At some point the virtual plan is discovered, or uncovered and the story (or episode) draws to a close.

While virtual plans are a common form that deception takes in stories, what we said about conflict applies here. There may be many kinds of deception and these can be catalogued and defined in terms of the kinds of plans in which they occur.

5.2 Other Factors that Would Make Complexity Make a Difference

A reader must be able to induce plans from the often sketchy statements of actions and intentions and then be able to use the induced plans to connect events. Several factors beyond those that are measurable by the interacting plans representation are the source of hypotheses about the process of comprehension.

5.2.1 Explicitness of the Text

Texts vary in the degree to which they are explicit about the plans and intentions of the characters in the story. Stories may be more difficult when the reader has to infer plan structures from the simple statements of actions. Texts need to be examined to determine how such things as virtual plans and conflicts are signaled. Other presentation media may present their own advantages and difficulties (Rubin, 1977). A story presented on film (without a narrator) may give very little indication of the underlying motives and intentions of the characters but may provide a rich source of non-verbal cues to emotional states and attitudes.

5.2.2 The Development of Role-taking Skills in Children

There is now a considerable body of research on the ability of children to take the perspective of another (Shantz, 1975). Where interacting plans are concerned, we would expect there to be some relation between the abilities this research investigates and story comprehension. For example, having to maintain different points of view (e.g., that one character believes X where another believes not-X, as in many cases of deception) may

impose demands on the reader. The ability to meet these demands may increase with age or reading experience. In addition to the levels of embedding mentioned above, there may be problems associated with maintaining a large number of differing beliefs or maintaining any differences for an extended period.

5.2 3 Critical Beliefs

Understanding stories that have interacting plans involves more than just the comprehension of complex embedded structures. Stories that involve beliefs about character types or simply facts about the physical world may place differential demands on readers depending on their experiences prior to reading. Often a single piece of world knowledge can play a critical role in deciding between one interpretation and another. We found it difficult, for example to change a small part of the representation without producing ripple effects throughout.

One consequence of this holistic property is that a single belief can assume tremendous importance. For example, the belief that the parents of Hansel and Gretel do their wood cutting at some distance from the home appears critical in their plan to include the children in the wood cutting expeditions. The wood fetching episode acts as a cover for the parent's real plan to abandon the children. Its effectiveness depends upon its believability, and ultimately on the belief that it is normal for the children to be taken along.

5.3 Learning to Read

What do interactive plans analyses tell us about learning to read? One thing is that understanding plans in stories is a complex task that may require years of exposure to high quality texts to learn. With regard to text characteristics, the interacting plans analyses that we have done illuminate a world of phenomena that are implicitly ignored in the design and selection of texts for use in school workbooks, tests, primers and textbooks. The texts often sacrifice the story line under the assumption that component skills of beginning reading need to be taught independently. Thus, it is assumed, story structure can be taught when its time comes; there is no need to demand high quality stories when one is teaching decoding of words to meaning. If an interacting plans analysis shows nothing else, it still demonstrates that a full understanding of even a "simple" fairy tale, requires sophisticated skills. Where are these skills to be learned, if not through reading (or being read) good texts?

It is only partly facetious to propose a text quality hierarchy of the following kinds:

1. Texts never seen in school
2. Texts allowed when the regular work is done
3. Texts read for a purpose other than learning to read
4. Texts used to teach reading
5. Texts used to test reading ability
6. Texts used to teach specific component skills (often used in remedial reading classes)

A reader who gets enough of types 1 and 2 will learn to enjoy reading, will learn that there is a point to reading, and will learn the skills necessary to read with understanding. These three types of learning exist in positive feedback loops, as shown in Figure 51. But the child who only sees texts at levels 3 and 4 or worse never enters the loops. He or she is then tested at level 5 and punished with level 6 texts for failure to perform on the test. While it is important to realize that reading is a complex skill, we must not assume that "simpler is better" with regards to text selection. Complexity is multidimensional; the best text may be one that challenges the reader on a few dimensions and allows easy success on others.

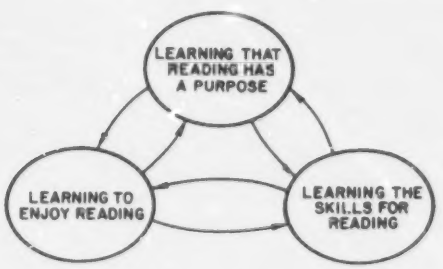


Figure 51. Learning to read

When one moves beyond the orthographic and lexical levels of analysis one finds more and more a tendency for texts to be understandable in different ways. We suspect that few three year olds, upon hearing "Hansel and Gretel", would understand it as an adult would. Yet their understanding, though possibly limited, is not wrong in the sense that saying "cat" to the

letters "D - O - G" would be wrong. The complexity of plans may mean that readers can understand in different ways, yet still be reading, and hence, learning to be better readers. Furthermore, the importance of critical beliefs suggests that readers with different backgrounds may build different interpretations of the same texts. It is a characteristic of interacting plans and, we think, of literature in general that one can uncover multiple meanings, no one of which is wrong, or even unsatisfying. The best approach may be to give children good literature, letting the child decide whether it is too complex.

6. Conclusion

We have presented here a way of representing the interacting plans of characters in stories. In developing the system and in applying it to the analysis of "Hansel and Gretel" we have used our own common sense knowledge and intuitions about social interaction. We assume that we share this knowledge and these intuitions with other (adult) readers of the story. We are not specialists in interpreting fairy tales although we have read this one rather closely. Rather, we were struck with how easy it was to view the characters as familiar and ordinary people who were engaged in a difficult conflict. That is, we found we could attribute our own knowledge and intuitions to the characters as though they were real.

It would be tempting, on this basis, to say that the system provides a way of representing actual social interaction. But while it seems reasonable that readers bring their ordinary

knowledge to bear on stories, we have to keep in mind the intentions of the author to make the story rational and coherent. The author's artfulness in constructing reasonable and informative dialogue, for example, may be covering over important processes that participants in conversations must engage in. We do not want to claim that our story analysis necessarily informs studies of social interaction. We do want to suggest, however, that this kind of story analysis is in a position to be informed by those studies. Readers find social interaction in stories and we are attempting to represent what they find.

References

Bettelheim, B. The uses of enchantment: The meaning and importance of fairy tales. New York: A. Kropf, Inc., 1976.

Bobrow, D.G., & Winograd, T. An overview of KRL, a knowledge representation language. Cognitive Science, 1977, 3, 3-46.

Bruce, B.C. Belief systems & language understanding. BBN Report No. 2973, Bolt Beranek & Newman Inc., Cambridge, Mass., 1975.

Bruce, B.C. Plans and social actions. To appear in R. Spiro, B. Bruce, and W. Brewer (Eds.), Theoretical issues in reading comprehension. Hillsdale, N.J.: Lawrence Erlbaum, 1978, in press. Also as Center for the Study of Reading Technical Report No. 34, University of Illinois at Urbana-Champaign, 1977.

Cohen, P.R. On knowing what to say: Planning speech acts. Ph.D Thesis, Department of Computer Science, Univ. of Toronto, Jan. 1978.

Grimm, The Brothers. Grimm's Fairy Tales. Trans. by Mrs. E.V. Lucas, L. Crane, & M. Edwards. New York: Grosset and Dunlap, 1945.

Perrault, C.R. & Cohen, P.R. Planning speech acts. AI-Memo 77-1, Department of Computer Science, Univ. of Toronto, April 1977.

Rubin, A.D. A theoretical taxonomy of the differences between oral and written language. To appear in R. Spiro, B. Bruce, and W. Brewer (Eds.), Theoretical issues in reading

comprehension. Hillsdale, N.J.: Lawrence Erlbaum, 1978, in press. Also as Center for the Study of Reading Technical Report No. 35, University of Illinois at Urbana-Champaign, 1977.

Rumelhart, D.E. Notes on a schema for stories. In D. Bobrow & A. Collins (Eds.), Representation and understanding: Studies in Cognitive Science. New York: Academic Press, 1975.

Sacerdoti, E.D.. The nonlinear nature of plans. Proceedings of the Fourth International Joint Conference on Artificial Intelligence. Tbilisi, USSR, 1975.

Schank, R.C. & Abelson, R.P. Scripts, plans, goals, and understanding. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1977.

Schiffer, S. R. Meaning. London: Oxford University Press, 1972.

Schmidt, C.F., Sridharan, N.S., & Goodson, J.L. The plan recognition problem: An intersection of artificial intelligence and psychology. To appear in Artificial Intelligence, 1978.

Shantz, C.U. The development of social cognition. In E.M. Hetherington (Ed.) Review of Child Development Research, Vol. 5. Chicago: University of Chicago Press, 1975.

Sussman, G. A Computer Model of Skill Acquisition. American Elsevier, N.Y., 1975.

Tate, A. Interacting goals and their use. Proceedings of the Fourth International Joint Conference on Artificial Intelligence. Tbilisi, Georgia, U.S.S.R., September 1975.

Waldinger, R. Achieving several goals simultaneously. Stanford Research Institute, Artificial Intelligence Group, Technical Note 107, 1975.

Appendix

Hansel and Gretel

(from Grimm, 1945)

Close to a large forest there lived a woodcutter with his wife and his two children. The boy was called Hansel and the girl Gretel. They were always very poor and had very little to live on. And at one time when there was famine in the land, he could no longer procure daily bread.

One night when he lay in bed worrying over his troubles, he sighed and said to his wife, "What is to become of us? How are we to feed our poor children when we have nothing for ourselves?"

"I'll tell you what, husband," answered the woman. "Tomorrow morning we will take the children out quite early into the thickest part of the forest. We will light a fire and give each of them a piece of bread. Then we will go to our work and leave them alone. They won't be able to find their way back, and so we shall be rid of them."

"Nay, wife," said the man, "we won't do that. I could never find it in my heart to leave my children alone in the forest. The wild animals would soon tear them to pieces."

"What a fool you are!" she said. "Then we must all four die of hunger. You may as well plane the boards for our coffins at once."

She gave him no peace till he consented. "But I grieve over the poor children all the same," said the man. The two children could not go to sleep for hunger either, and they heard what their stepmother said to their father.

Gretel wept bitterly and said, "All is over with us now."

"Be quiet, Gretel," said Hansel. "Don't cry! I will find some way out of it."

When the old people had gone to sleep, he got up, put on his little coat, opened the door, and slipped out. The moon was shining brightly and the white pebbles round the house shone like newly minted coins. Hansel stooped down and put as many into his pockets as they would hold.

Then he went back to Gretel and said, "Take comfort, little sister, and go to sleep. God won't forsake us." And then he went to bed again.

At daybreak, before the sun had risen, the woman came and said, "Get up, you lazybones! We are going into the forest to fetch wood."

Then she gave them each a piece of bread and said, "Here is something for your dinner, but don't eat it before then, for you'll get no more."

Gretel put the bread under her apron, for Hansel had the stones in his pockets. Then they all started for the forest.

When they had gone a little way, Hansel stopped and looked back at the cottage, and he did the same thing again and again.

His father said, "Hansel, what are you stopping to look back at? Take care and put your best foot foremost."

"Oh, father," said Hansel, "I am looking at my white cat. It is sitting on the roof, wanting to say good-by to me."

"Little fool, that's no cat! It's the morning sun shining on the chimney," said the mother.

But Hansel had not been looking at the cat. He had been dropping a pebble on the ground each time he stopped.

When they reached the middle of the forest, their father said, "Now, children, pick up some wood. I want to make a fire to warm you."

Hansel and Gretel gathered the twigs together and soon made a huge pile. Then the pile was lighted, and when it blazed up the woman said, "Now lie down by the fire and rest yourselves while we go and cut wood. When we have finished we will come back to fetch you."

Hansel and Gretel sat by the fire, and when dinnertime came they each ate their little bit of bread, and they thought their father was quite near because they could hear the sound of an ax. It was no ax, however, but a branch which the man had tied to a dead tree, and which blew backwards and forwards against it. They sat there so long that they got tired. Then their eyes began to close and they were soon fast asleep.

When they woke it was dark night. Gretel began to cry, "How shall we ever get out of the wood?"

But Hansel comforted her and said, "Wait a little while till the moon rises, and then we will soon find our way."

When the full moon rose, Hansel took his little sister's hand and they walked on, guided by the pebbles, which glittered like newly coined money. They walked the whole night, and at daybreak they found themselves back at their father's cottage.

They knocked at the door, and when the woman opened it and saw Hansel and Gretel she said, "You bad children, why did you

sleep so long in the wood? We thought you did not mean to come back any more."

But their father was delighted, for it had gone to his heart to leave them behind alone.

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